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DECLARATION

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Dated this 8th day of March, 2004

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[DOCUMENT NAME] SPECIFICATION

[TITLE OF THE INVENTION] INK FOR INK JET, METHOD OF  
PRODUCING INK FOR INK JET, AND INK JET RECORDING METHOD

[CLAIMS]

[Claim 1] An ink for ink jet, the ink comprising:

a colored fine particle dispersion including at least a hydrophobic high-boiling organic solvent having a boiling point of at least 150 °C and an oil-soluble dye; and

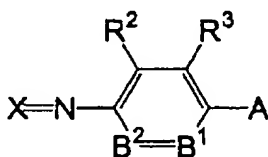
an ionic group-containing water-insoluble polymer added to the colored fine particle dispersion.

[Claim 2] The ink of claim 1, wherein the ionic group-containing water-insoluble polymer added to the colored fine particle dispersion is included in a fine particle dispersion prepared by emulsification dispersion of the ionic group-containing water-insoluble polymer.

[Claim 3] The ink of claim 1 or 2, wherein the oil-soluble dye is represented by the following general formula (I):

[Formula 1]

General formula (I)





wherein X represents a residue of a color-photographic coupler; A represents  $-NR^4R^5$  or a hydroxyl group;  $R^4$  and  $R^5$  each independently represents a hydrogen atom, an aliphatic group, an aromatic group or a heterocyclic group;  $B^1$  represents  $=C(R^6)-$  or  $=N-$ ;  $B^2$  represents  $-C(R^7)=$  or  $-N=$ ;  $R^2$ ,  $R^3$ ,  $R^6$  and  $R^7$  each independently represents a hydrogen atom, a halogen atom, an aliphatic group, an aromatic group, a heterocyclic group, a cyano group,  $-OR^{51}$ ,  $-SR^{52}$ ,  $-CO_2R^{53}$ ,  $-OCOR^{54}$ ,  $-NR^{55}R^{56}$ ,  $-CONR^{57}R^{58}$ ,  $-SO_2R^{59}$ ,  $-SO_2NR^{60}R^{61}$ ,  $-NR^{62}CONR^{63}R^{64}$ ,  $-NR^{65}CO_2R^{66}$ ,  $-COR^{67}$ ,  $-NR^{68}COR^{69}$  or  $-NR^{70}SO_2R^{71}$ ;  $R^{51}$ ,  $R^{52}$ ,  $R^{53}$ ,  $R^{54}$ ,  $R^{55}$ ,  $R^{56}$ ,  $R^{57}$ ,  $R^{58}$ ,  $R^{59}$ ,  $R^{60}$ ,  $R^{61}$ ,  $R^{62}$ ,  $R^{63}$ ,  $R^{64}$ ,  $R^{65}$ ,  $R^{66}$ ,  $R^{67}$ ,  $R^{68}$ ,  $R^{69}$ ,  $R^{70}$  and  $R^{71}$  each independently represents a hydrogen atom, an aliphatic group or an aromatic group; and  $R^2$  and  $R^3$ ,  $R^3$  and  $R^4$ ,  $R^4$  and  $R^5$ ,  $R^5$  and  $R^6$ , and  $R^6$  and  $R^7$  may be bound to each other to form a ring.

[Claim 4] The ink of any of claims 1 to 3, wherein the content of the hydrophobic high-boiling organic solvent in the colored fine particles is 25 % by mass or more.

[Claim 5] The ink of any of claims 1 to 4, wherein the ionic group-containing water-insoluble polymer comprises ionic groups in the amount of 0.01 to 3.0 mmol/g.

[Claim 6] The ink of any of claims 1 to 5, wherein the ionic group-containing water-insoluble polymer comprises at least one of a carboxyl group and a sulfonic acid group.

[Claim 7] The ink of any of claims 1 to 6, wherein the relative dielectric constant at 25 °C of the hydrophobic high-boiling organic solvent is from 3 to 12.

[Claim 8] The ink of any of claims 1 to 7, wherein the colored fine particle dispersion comprises colored fine particles with an average particle diameter of at most 100 nm.

[Claim 9] An ink jet recording method using the ink for ink jet of any of claims 1 to 8.

[Claim 10] The method of claim 9, wherein an image-receiving material for recording comprises a support and, on the support, an ink-receiving layer including a porous inorganic pigment.

[Claim 11] A method of producing an ink for ink jet, the method comprising the steps of:

dispersing colored fine particles, which include at least a hydrophobic high-boiling organic solvent having a boiling point of at least 150 °C and an oil-soluble dye, in an aqueous medium to prepare a colored fine particle dispersion;

dispersing by emulsification of an ionic group-containing water-insoluble polymer to prepare a fine particle dispersion; and

mixing the fine particle dispersion with the colored fine particle

dispersion.

## [DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to an ink for ink jet comprising an aqueous colored fine particle dispersion containing an oil-soluble dye, a method of manufacturing the ink for ink jet, and an ink jet recording method using the ink for ink jet. In particular, the present invention relates to an ink for ink jet preferable for a thermal, piezoelectric, electric field or acoustic ink jet recording system, excellent in the qualities of recorded images, superior in image water resistance and image fastness properties and excellent in the stability of the ink with time and in discharge stability, as well as a method of manufacturing said ink for ink jet and an ink jet recording method using the same.

[0002]

[Prior Art]

As computers have spread in recent years, ink jet printers are widely utilized for printing on paper, film, cloth, etc. not only in offices but also in homes. As inks for ink jet recording, there are known oily, aqueous and solid inks, among which the aqueous inks are mainly used, because of advantages such as easy production, handling, smelling, safety, etc.

[0003]

Many of these aqueous inks make use of water-soluble dyes to be dissolved in a molecular state, so there are the advantages of high transparency and high color density, but because these dyes are water-soluble, there are the problem of insufficient water resistance causing bleeding which deteriorates qualities upon printing on paper, as well as poor light resistance.

[0004]

For the purpose of solving the problems described above, aqueous inks using pigments or dispersed dyes are proposed in e.g. JP-A 56-157468, JP-A 4-18468, JP-A 8-183920, JP-A 10-110126 and JP-A 10-195355.

However, there are the problems that the water resistance of these aqueous inks is improved at a certain degree but is still not satisfactory, the pigment inks are inferior in coloration to the dye inks, the above pigment inks or dye-dispersed inks are poor in shell stability and easily cause clogging in nozzles for discharge of ink.

In addition, a recording paper provided thereon with an ink receiving layer containing a porous inorganic pigment (hereinafter also referred to as "photograph-quality paper"), which came to be used with an increasing demand for high-quality pictures in recent ink jet technology, is poor in stainability with said aqueous inks using pigments or dispersed dyes, and such pigments or dyes are easily removed from the surface upon rubbing with hands.

[0005]

In addition, JP-A 58-45272, JP-A 6-340835, JP-A 7-268254, JP-A 7-268257 and JP-A 7-268260 propose respectively a method wherein a dye is included in polyurethane- or polyester-dispersed particles.

However, the dispersions described in these literatures have the disadvantage that colored particles excellent in dispersion stability are hardly obtained when the dye is included at a desired concentration, and these dispersions also have the above-described problem of removal of the dye.

[0006]

Further, JP-A 10-279873 discloses a method of producing colored polymer fine particles by dissolving an acrylic polymer and an oil-soluble dye in an organic solvent, dispersing them, and removing the organic solvent, but there is a problem with the qualities of recorded images particularly on a photograph-quality paper medium or with stability in continuous recording, and another problem is that the stability of the dispersion with time cannot be satisfactory.

[0007]

On the other hand, JP-B 5-76977 discloses an ink composition wherein an oil-soluble dye is dissolved and dispersed in an organic solvent having low water solubility and specific gravity similar to that of water, but it was revealed that the organic solvent defined therein is

generally poor in compatibility with the oil-soluble dye, thus making recording density low, and in some cases the dye is precipitated during storage to cause clogging of nozzles. Further, this dispersion similar to those dispersions described above also has a problem in stability with time.

[0008]

[Problems to be Solved by the Invention]

The problem of the present invention is to solve the problems described in the prior art described above thereby achieving the following object.

The object of the present invention is to provide an ink for ink jet preferable for a thermal, piezoelectric, electric field or acoustic ink jet recording system, not depending on paper, excellent in color reproduction and color tone upon printing on an arbitrarily selected paper, capable of high recording density, excellent in ink penetration into a photograph-quality paper, solving the problem of staining just after printing, excellent in image water resistance and image fastness properties, and also excellent in the stability of the ink with time and in discharge stability, a method of manufacturing said ink for ink jet, and an ink jet recording method capable of high-quality recording by use of said ink for ink jet.

[0009]

[Means for Solving the Problems]

The means for solving the problem described above is as follows:

<1> an ink for ink jet, the ink comprising:

a colored fine particle dispersion including at least a hydrophobic high-boiling organic solvent having a boiling point of at least 150 °C and an oil-soluble dye; and

an ionic group-containing water-insoluble polymer added to the colored fine particle dispersion;

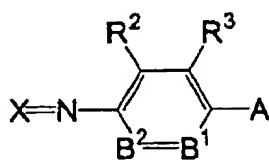
<2> the ink of <1>, wherein the ionic group-containing water-insoluble polymer added to the colored fine particle dispersion is included in a fine particle dispersion prepared by emulsification dispersion of the ionic group-containing water-insoluble polymer;

<3> the ink of <1> or <2>, wherein the oil-soluble dye is represented by the following general formula (I):

[0010]

[Formula 2]

General formula (I)



[0011]

wherein X represents a residue of a color-photographic coupler; A represents -NR<sup>4</sup>R<sup>5</sup> or a hydroxyl group; R<sup>4</sup> and R<sup>5</sup> each independently represents a hydrogen atom, an aliphatic group, an aromatic group or a

heterocyclic group; B<sup>1</sup> represents =C(R<sup>6</sup>)– or =N–; B<sup>2</sup> represents –C(R<sup>7</sup>)= or –N=; R<sup>2</sup>, R<sup>3</sup>, R<sup>6</sup> and R<sup>7</sup> each independently represents a hydrogen atom, a halogen atom, an aliphatic group, an aromatic group, a heterocyclic group, a cyano group, –OR<sup>51</sup>, –SR<sup>52</sup>, –CO<sub>2</sub>R<sup>53</sup>, –OCOR<sup>54</sup>, –NR<sup>55</sup>R<sup>56</sup>, –CONR<sup>57</sup>R<sup>58</sup>, –SO<sub>2</sub>R<sup>59</sup>, –SO<sub>2</sub>NR<sup>60</sup>R<sup>61</sup>, –NR<sup>62</sup>CONR<sup>63</sup>R<sup>64</sup>, –NR<sup>65</sup>CO<sub>2</sub>R<sup>66</sup>, –COR<sup>67</sup>, –NR<sup>68</sup>COR<sup>69</sup> or –NR<sup>70</sup>SO<sub>2</sub>R<sup>71</sup>; R<sup>51</sup>, R<sup>52</sup>, R<sup>53</sup>, R<sup>54</sup>, R<sup>55</sup>, R<sup>56</sup>, R<sup>57</sup>, R<sup>58</sup>, R<sup>59</sup>, R<sup>60</sup>, R<sup>61</sup>, R<sup>62</sup>, R<sup>63</sup>, R<sup>64</sup>, R<sup>65</sup>, R<sup>66</sup>, R<sup>67</sup>, R<sup>68</sup>, R<sup>69</sup>, R<sup>70</sup> and R<sup>71</sup> each independently represents a hydrogen atom, an aliphatic group or an aromatic group; and R<sup>2</sup> and R<sup>3</sup>, R<sup>3</sup> and R<sup>4</sup>, R<sup>4</sup> and R<sup>5</sup>, R<sup>5</sup> and R<sup>6</sup>, and R<sup>6</sup> and R<sup>7</sup> may be bound to each other to form a ring;

[0012]

<4> the ink of any of <1> to <3>, wherein the content of the hydrophobic high-boiling organic solvent in the colored fine particles is 25 % by mass or more;

<5> the ink of any of <1> to <4>, wherein the ionic group-containing water-insoluble polymer comprises ionic groups in the amount of 0.01 to 3.0 mmol/g;

<6> the ink of any of <1> to <5>, wherein the ionic group-containing water-insoluble polymer comprises at least one of a carboxyl group and a sulfonic acid group;

<7> the ink of any of <1> to <6>, wherein the relative dielectric constant at 25 °C of the hydrophobic high-boiling organic solvent is from 3 to 12;

<8> the ink of any of <1> to <7>, wherein the colored fine particle dispersion comprises colored fine particles with an average particle



diameter of at most 100 nm;

<9> an ink jet recording method using the ink for ink jet of any of <1> to <8>;

<10> the method of <9>, wherein an image-receiving material for recording comprises a support and, on the support, an ink-receiving layer including a porous inorganic pigment; and

<11> a method of producing an ink for ink jet, the method comprising the steps of:

dispersing colored fine particles, which include at least a hydrophobic high-boiling organic solvent having a boiling point of at least 150 °C and an oil-soluble dye, in an aqueous medium to prepare a colored fine particle dispersion;

dispersing by emulsification of an ionic group-containing water-insoluble polymer to prepare a fine particle dispersion; and

mixing the fine particle dispersion with the colored fine particle dispersion.

[0013]

[Embodiments]

(Ink for ink jet)

Hereinafter, the ink for ink jet according to the present invention is described.

The ink for ink jet according to the present invention includes an ionic group-containing water-insoluble polymer added to a colored fine particle dispersion containing at least a hydrophobic high-boiling organic

solvent having a boiling point of 150 °C or more and an oil-soluble dye.

[0014]

<Colored Fine Particle Dispersion>

Now, the colored fine particle dispersion is described.

The colored fine particle dispersion of the present invention comprises a colored fine particle dispersion containing at least a hydrophobic high-boiling organic solvent having a boiling point of 150 °C or more and an oil-soluble dye dispersed in an aqueous medium.

Specifically, the colored fine particle dispersion of the present invention is a dispersion wherein a hydrophobic high-boiling organic solvent having a boiling point of 150 °C or more and an oil-soluble dye are dispersed as fine oil droplets (that is, in an emulsified and dispersed state) in an aqueous medium.

The "aqueous medium" in the present invention refers to water or a mixture of water and a small amount of a water-miscible organic solvent, to which additives such as a surfactant, a wetting agent, a stabilizer, a preservative, etc. have been added as necessary.

[0015]

- Oil-soluble Dye -

The oil-soluble dye contained in the colored fine particle dispersion is described.

Of oil-soluble dyes usable in the present invention, a yellow dye may be an arbitrary one. Examples thereof include aryl or heteryl azo

dyes having phenols, naphthols, anilines, pyrazolones, pyridones, or closed-chain active methylene compounds as coupling components; azomethine dyes having closed-chain methylene compounds as coupling components; methine dyes such as benzylidene dye and monomethine oxonol dye; quinone type dyes such as naphthoquinone dye, anthraquinone dye, etc., and other dyes including quinophthalone dyes, nitro-nitroso dyes, acridine dyes and acridinone dyes.

[0016]

Of the oil-soluble dyes usable in the present invention, a magenta dye may be an arbitrary one. Examples thereof include aryl or heteryl azo dyes having phenols, naphthols or anilines as coupling components; azomethine dyes having pyrazolones or pyrazolotriazoles as coupling components; methine dyes such as allylidene dye, styryl dye, merocyanine dye, and oxonol dye; carbonium dyes such as diphenyl methane dye, triphenyl methane dye and xanthene dye; quinone type dyes such as naphthoquinone, anthraquinone and anthraxpyridone; and fused polycyclic dyes such as dioxazine dyes.

[0017]

Of the oil-soluble dyes usable in the present invention, a cyan dye may be an arbitrary one. Examples thereof include indoaniline dyes, indophenol dyes, or azomethine dyes having pyrrolotriazoles as coupling components; polymethine dyes such as cyanine dye, oxonol dye and merocyanine dye; carbonium dyes such as diphenyl methane dye,

triphenyl methane dye and xanthene dye; phthalocyanine dye; anthraquinone dye; aryl or heteryl azo dyes and indigo thioindigo dyes having phenols, naphthols or anilines as coupling components.

[0018]

The respective dyes described above may be those showing a yellow, magenta or cyan color upon dissociation of a portion of chromophores, and the counter cation in this case may be an alkali metal or an inorganic cation such as ammonium, or may be an organic cation such as pyridium or quaternary ammonium salt or a polymer cation having the same in partial structure.

[0019]

Among these oil-soluble dyes, preferable examples include, but are not limited to, the following.

Preferable examples are C.I. Solvent Black 3, 7, 27, 29 and 34; C.I. Solvent Yellow 14, 16, 19, 29, 30, 56, 82, 93 and 162; C.I. Solvent Red 1, 3, 8, 18, 24, 27, 43, 49, 51, 72, 73, 109, 122, 132 and 218; C.I. Solvent Violet 3; C.I. Solvent Blue 2, 11, 25, 35 and 70; C.I. Solvent Green 3 and 7; and C.I. Solvent Orange 2, etc.

More preferable examples are Nubian Black PC-0850, Oil Black HBB, Oil Yellow 129, Oil Yellow 105, Oil Pink 312, Oil Red 5B, Oil Scarlet 308, Vali Fast Blue 2606, Oil Blue BOS<sup>TM</sup> (Orient Kagaku Co., Ltd.), Neopen Yellow 075, Neopen Magenta SE1378, Neopen Blue 808, Neopen Blue FF4012, and Neopen Cyan FF4238<sup>TM</sup> (BASF).

[0020]

In the present invention, dispersion dyes can also be used within a range in which they are dissolved in a water-immiscible organic solvent, and preferable examples thereof include, but are not limited to, the followings.

Preferable examples include C.I. Disperse Yellow 5, 42, 54, 64, 79, 82, 83, 93, 99, 100, 119, 122, 124, 126, 160, 184:1, 186, 198, 199, 201, 204, 224 and 237; C.I. Disperse Orange 13, 29, 31:1, 33, 49, 54, 55, 66, 73, 118, 119 and 163; C.I. Disperse Red 54, 60, 72, 73, 86, 88, 91, 92, 93, 111, 126, 127, 134, 135, 143, 145, 152, 153, 154, 159, 164, 167, 177, 181, 204, 206, 207, 221, 239, 240, 258, 277, 278, 283, 311, 323, 343, 348, 356 and 362; C.I. Disperse Violet 33; C.I. Disperse Blue 56, 60, 73, 87, 113, 128, 143, 148, 154, 158, 165, 165:1, 165:2, 176, 183, 185, 197, 198, 201, 214, 224, 225, 257, 266, 267, 287, 354, 358, 365 and 368; and C.I. Disperse Green 6:1 and 9, etc.

[0021]

Among the oil-soluble dyes, colorants for color-photographic material, which are produced by oxidation of couplers and developing agents, are preferable. Among them, the compound represented by the following formula (I) is more preferable.

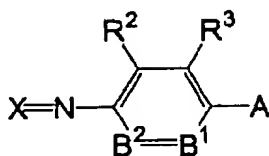
The compounds represented by formula (I) are described, and are preferably compounds wherein at least one group in the formula (I) is within the preferable scope defined below, more preferably those

compounds wherein more groups are within the preferable scope and most preferably those compounds wherein all groups are within the preferable scope.

[0022]

[Formula 3]

General formula (I)



[0023]

In the formula (I) above, X represents a residue of a color-photographic coupler; A represents -NR<sup>4</sup>R<sup>5</sup> or a hydroxyl group; and R<sup>4</sup> and R<sup>5</sup> each independently represents a hydrogen atom, an aliphatic group, an aromatic group or a heterocyclic group.

A is preferably -NR<sup>4</sup>R<sup>5</sup>, and each of R<sup>4</sup> and R<sup>5</sup> is preferably a hydrogen atom and an aliphatic group, more preferably a hydrogen atom an alkyl group or a substituted alkyl group, and most preferably a hydrogen atom, a C<sub>1-18</sub> alkyl group or a C<sub>1-18</sub> substituted alkyl group.

[0024]

In the formula (I) above, B<sup>1</sup> represents =C(R<sup>6</sup>)- or =N-; B<sup>2</sup> represents -C(R<sup>7</sup>)= or -N=; preferably, B<sup>1</sup> and B<sup>2</sup> are not simultaneously -N=, and more preferably B<sup>1</sup> is =C(R<sup>6</sup>)-, and B<sup>2</sup> is -C(R<sup>7</sup>)=.

[0025]

In the formula (I) above,  $R^2$ ,  $R^3$ ,  $R^6$  and  $R^7$  each independently represents a hydrogen atom, a halogen atom, an aliphatic group, an aromatic group, a heterocyclic group, a cyano group,  $-OR^{51}$ ,  $-SR^{52}$ ,  $-CO_2R^{53}$ ,  $-OCOR^{54}$ ,  $-NR^{55}R^{56}$ ,  $-CONR^{57}R^{58}$ ,  $-SO_2R^{59}$ ,  $-SO_2NR^{60}R^{61}$ ,  $-NR^{62}CONR^{63}R^{64}$ ,  $-NR^{65}CO_2R^{66}$ ,  $-COR^{67}$ ,  $-NR^{68}COR^{69}$  or  $-NR^{70}SO_2R^{71}$ .

$R^{51}$ ,  $R^{52}$ ,  $R^{53}$ ,  $R^{54}$ ,  $R^{55}$ ,  $R^{56}$ ,  $R^{57}$ ,  $R^{58}$ ,  $R^{59}$ ,  $R^{60}$ ,  $R^{61}$ ,  $R^{62}$ ,  $R^{63}$ ,  $R^{64}$ ,  $R^{65}$ ,  $R^{66}$ ,  $R^{67}$ ,  $R^{68}$ ,  $R^{69}$ ,  $R^{70}$  and  $R^{71}$  each independently represents a hydrogen atom, an aliphatic group or an aromatic group.

[0026]

Among these groups, each of  $R^2$  and  $R^7$  is preferably a hydrogen atom, a halogen atom, an aliphatic group,  $-OR^{51}$ ,  $-NR^{62}CONR^{63}R^{64}$ ,  $-NR^{65}CO_2R^{66}$ ,  $-NR^{68}COR^{69}$  or  $-NR^{70}SO_2R^{71}$ ; more preferably a hydrogen atom, a fluorine atom, a chlorine atom, an alkyl group, a substituted alkyl group,  $-NR^{62}CONR^{63}R^{64}$  or  $-NR^{68}COR^{69}$ ; particularly preferably a hydrogen atom, a chlorine atom, a  $C_{1-10}$  alkyl group or a  $C_{1-10}$  substituted alkyl group; and most preferably a hydrogen atom, a  $C_{1-4}$  alkyl group and a  $C_{1-4}$  substituted alkyl group.

[0027]

Among these groups, each of  $R^3$  and  $R^6$  is preferably a hydrogen atom, a halogen atom or an aliphatic group, more preferably a hydrogen atom, a fluorine atom, a chlorine atom, an alkyl group or a substituted alkyl group, particularly preferably a hydrogen atom, a chlorine atom, a

C<sub>1-10</sub> alkyl group or a C<sub>1-10</sub> substituted alkyl group, and most preferably a hydrogen atom, a C<sub>1-4</sub> alkyl group or a C<sub>1-4</sub> substituted alkyl group.

[0028]

In the formula (I) above, R<sup>2</sup> and R<sup>3</sup>, R<sup>3</sup> and R<sup>4</sup>, R<sup>4</sup> and R<sup>5</sup>, R<sup>5</sup> and R<sup>6</sup>, and R<sup>6</sup> and R<sup>7</sup> may mutually bond to form a ring. The combinations that form rings are particularly preferably the combinations R<sup>3</sup> and R<sup>4</sup>, R<sup>4</sup> and R<sup>5</sup>, and R<sup>5</sup> and R<sup>6</sup>.

[0029]

A ring formed by mutual linkage of R<sup>2</sup> and R<sup>3</sup> or R<sup>6</sup> and R<sup>7</sup> is preferably a 5- or 6-membered ring. The ring is preferably an aromatic ring (e.g., a benzene ring, etc.) or an unsaturated heterocyclic ring (e.g., a pyridine ring, imidazole ring, thiazole ring, pyrimidine ring, pyrrole ring, furan ring, etc.).

A ring formed by mutual linkage of R<sup>3</sup> and R<sup>4</sup> or R<sup>5</sup> and R<sup>6</sup> is preferably a 5- or 6-membered ring. The ring is preferably a tetrahydroquinoline ring or dihydroindole ring.

A ring formed by mutual linkage of R<sup>4</sup> and R<sup>5</sup> is preferably a 5- or 6-membered ring. The ring is preferably a pyrrolidine ring, piperidine ring or morpholine ring.

[0030]

In this specification, an aliphatic group means an alkyl group, substituted alkyl group, alkenyl group, substituted alkenyl group,



alkynyl group, substituted alkynyl group, aralkyl group or substituted aralkyl group.

The aralkyl group may be branched or cyclic. The number of carbon atoms in the alkyl group is preferably 1 to 20, more preferably 1 to 18.

The alkyl moiety in the substituted alkyl group is the same as the above-described alkyl group.

The alkenyl group may be branched or cyclic. The number of carbon atoms in the alkenyl group is preferably 2 to 20, more preferably 2 to 18.

The alkenyl moiety in the substituted alkenyl group is the same as the above-described alkenyl group.

The alkynyl group may be branched or cyclic. The number of carbon atoms in the alkynyl group is preferably 2 to 20, more preferably 2 to 18.

The alkynyl moiety in the substituted alkynyl group is the same as the above-described alkyl group.

The alkyl moiety in the aralkyl group and the substituted aralkyl group is the same as the above-described alkyl group.

The aryl moiety in the aralkyl group and the substituted aralkyl group is the same as the above-described aryl group.

Substituent groups on the alkyl moieties in the substituted alkyl group, the substituted alkenyl group, the substituted alkynyl group and the substituted aralkyl group include e.g. a halogen atom, a cyano group, a nitro group, a heterocyclic group,  $-OR^{111}$ ,  $-SR^{112}$ ,  $-CO_2R^{113}$ ,  $-NR^{114}R^{115}$ , -

OCNR<sup>116</sup>R<sup>117</sup>, -SO<sub>2</sub>R<sup>118</sup> and -SO<sub>2</sub>NR<sup>119</sup>R<sup>120</sup>.

R<sup>111</sup>, R<sup>112</sup>, R<sup>113</sup>, R<sup>114</sup>, R<sup>115</sup>, R<sup>116</sup>, R<sup>117</sup>, R<sup>118</sup>, R<sup>119</sup> and R<sup>120</sup> each independently represents a hydrogen atom, an aliphatic group or an aromatic group.

Substituent groups on the aryl moiety in the substituted aralkyl group are the same as substituent groups on the substituted aryl group described below.

[0031]

In this specification, an aromatic group means an aryl group or a substituted aryl group.

The aryl group is preferably a phenyl group or a naphthyl group, more preferably a phenyl group.

The aryl moiety in the substituted aryl group is the same as the above-described aryl group.

Substituent groups on the substituted aryl group include a halogen atom, a cyano group, a nitro group, an aliphatic group, a heterocyclic group, -OR<sup>121</sup>, -SR<sup>122</sup>, -CO<sub>2</sub>R<sup>123</sup>, -NR<sup>124</sup>R<sup>125</sup>, -CONR<sup>126</sup>R<sup>127</sup>, -SO<sub>2</sub>R<sup>128</sup> and -SO<sub>2</sub>NR<sup>129</sup>R<sup>130</sup>.

R<sup>121</sup>, R<sup>122</sup>, R<sup>123</sup>, R<sup>124</sup>, R<sup>125</sup>, R<sup>126</sup>, R<sup>127</sup>, R<sup>128</sup>, R<sup>129</sup> and R<sup>130</sup> each independently represents a hydrogen atom, an aliphatic group or an aromatic group.

[0032]

In this specification, heterocyclic groups include groups having

either a saturated heterocyclic ring or an unsaturated heterocyclic group. The heterocyclic ring is preferably a 5- or 6-membered ring. Further, the heterocyclic ring may have an aliphatic ring, an aromatic ring or another heterocyclic ring fused therewith.

The hetero-atom in the heterocyclic ring includes e.g. a boron atom, a nitrogen atom, an oxygen atom, a sulfur atom, a selenium atom, a tellurium atom, etc. Among these atoms, a nitrogen atom, an oxygen atom and a sulfur atom are preferable.

The heterocyclic ring is preferably a ring wherein of the atoms constituting the heterocyclic ring, a carbon atom has a free valence (monovalence) (the heterocyclic ring is bound via the carbon atom).

The saturated heterocyclic ring includes e.g. a pyrrolidine ring, a morpholine ring, a 2-bora-1,3-dioxolane ring and a 1,3-thiazolidine ring.

The unsaturated heterocyclic ring includes an imidazole ring, a thiazole ring, a benzothiazole ring, a benzoxazole ring, a benzotriazole ring, a benzoselenazole ring, a pyridine ring, a pyrimidine ring and a quinoline ring.

The heterocyclic ring may have a substituent group. The substituent group includes a halogen atom, a cyano group, a nitro group, an aliphatic group, an aromatic group, a heterocyclic group,  $-OR^{131}$ ,  $-SR^{132}$ ,  $-CO_2R^{133}$ ,  $-NR^{134}R^{135}$ ,  $-CONR^{136}R^{137}$ ,  $-SO_2R^{138}$  and  $-SO_2NR^{139}R^{140}$ .

$R^{131}$ ,  $R^{132}$ ,  $R^{133}$ ,  $R^{134}$ ,  $R^{135}$ ,  $R^{136}$ ,  $R^{137}$ ,  $R^{138}$ ,  $R^{139}$  and  $R^{140}$  each independently represents a hydrogen atom, an aliphatic group or an aromatic group.

[0033]

The couplers described above are preferably the following couplers.

The yellow couplers include the couplers represented by formulae (I) and (II) in US Patent Nos. 3,933,501, 4,022,620, 4,326,024, 4,401,752 and 4,248,961, JP-B 58-10739, British Patent Nos. 1,425,020 and 1,476,760, US Patent Nos. 3,973,968, 4,314,023 and 4,511,649, European Patent Nos. 249,473A and 502,424A, the couplers represented by formulae (1) and (2) (particularly Y-28 on page 18) in European Patent No. 513,496A, the couplers represented by formula (I) in claim 1 in European Patent No. 568,037A, the couplers represented by formula (I) in lines 45 to 55 in column 1 in US Patent No. 5,066,576, the couplers represented by formula (I) in column 0008 in JP-A 4-274,425, the couplers described in claim 1 on page 40 (particularly D-35 on page 18) in European Patent No. 498,381A1, the couplers represented by formula (Y) on page 4 (particularly Y-1 (page 17) and Y-54 (page 41)) in European Patent No. 447,969A1, the couplers represented by formulae (II) to (IV) in lines 36 to 58 in column 7 (particularly II-17, II-19 (column 17), and II-24 (column 19)) in US Patent No. 4,476,219.

[0034]

The magenta couplers include those in US Patent Nos. 4,310,619, 4,351,897, European Patent No. 73,636, US Patent Nos. 3,061,432 and 3,725,067, Research Disclosure No. 24220 (June, 1984), Research Disclosure No. 24230 (June, 1984), JP-A 60-33552, JP-A 60-43659, JP-

A 61-72238, JP-A 60-35730, JP-A 55-118034, JP-A 60-185951, US Patent Nos. 4,500,630, 4,540,654 and 4,556,630, International Publication WO88/04795, JP-A 3-39737 (L-57 (lower right column on page 11), L-68 (lower right column on page 12), L-77 (lower right column on page 13)), [A-4]-63 (page 134) and [A-4]-73, and [A-4]-75 (page 139) in European Patent No. 456,257, M-4, M-6 (page 26) and M-7 (page 27) in European Patent No. 486,965, M-45 (page 19) in European Patent No. 571,959A, (M-1) (page 6) in JP-A 5-204106, and M-22 in paragraph 0237 of JP-A 4-362631.

[0035]

The cyan couplers include the couplers in US Patent Nos. 4,052,212, 4,146,396, 4,228,233 and 4,296,200, European Patent No. 73,636, CX-1, -3, -4, -5, -11, -12, -14 and -15 (pages 14 to 16) in JP-A 4-204843; C-7, 10 (page 35), 34, and 35 (page 37), (I-1) and (I-17) (pages 42 to 43) in JP-A 4-43345; and the couplers represented by formula (Ia) or (Ib) in claim 1 in JP-A 6-67385.

[0036]

In addition, the couplers described in JP-A 62-215272 (page 91), JP-A 2-33144 (pages 3 and 30), EP355,660A (pages, 4, 5, 45 and 47) are also useful.

[0037]

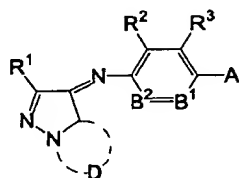
Among the compounds represented by formula (I) above, the

magenta dyes are more preferably compounds represented by formula (II).

[0038]

[Formula 4]

General formula (II)



[0039]

In formula (II) above, R<sup>1</sup> represents a hydrogen atom, an aliphatic group, an aromatic group, a heterocyclic group, a cyano group, -OR<sup>11</sup>, -SR<sup>12</sup>, -CO<sub>2</sub>R<sup>13</sup>, -OCOR<sup>14</sup>, -NR<sup>15</sup>R<sup>16</sup>, -CONR<sup>17</sup>R<sup>18</sup>, -SO<sub>2</sub>R<sup>19</sup>, -SO<sub>2</sub>NR<sup>20</sup>R<sup>21</sup>, -NR<sup>22</sup>CONR<sup>23</sup>R<sup>24</sup>, -NR<sup>25</sup>CO<sub>2</sub>R<sup>26</sup>, -COR<sup>27</sup>, -NR<sup>28</sup>COR<sup>29</sup> or -NR<sup>30</sup>SO<sub>2</sub>R<sup>31</sup>; R<sup>11</sup>, R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup>, R<sup>15</sup>, R<sup>16</sup>, R<sup>17</sup>, R<sup>18</sup>, R<sup>19</sup>, R<sup>20</sup>, R<sup>21</sup>, R<sup>22</sup>, R<sup>23</sup>, R<sup>24</sup>, R<sup>25</sup>, R<sup>26</sup>, R<sup>27</sup>, R<sup>28</sup>, R<sup>29</sup>, R<sup>30</sup> and R<sup>31</sup> each independently represents a hydrogen atom, an aliphatic group or an aromatic group; and R<sup>2</sup>, R<sup>3</sup>, A, B<sup>1</sup> and B<sup>2</sup> have the same meanings as defined in formula (I) above and their preferable scope is the same as defined above.

[0040]

In the formula (II) above, D represents an atomic group forming a 5- or 6-membered nitrogenous heterocyclic ring which may be

substituted with at least one substituent group. Further, said heterocyclic ring may further form a fused ring with another ring.

At least one substituent group on the atomic group forming a 5- or 6-membered nitrogenous heterocyclic ring, represented by D, is an aliphatic group, an aromatic group, a heterocyclic group, a cyano group,  $-OR^{81}$ ,  $-SR^{82}$ ,  $-CO_2R^{83}$ ,  $-OCOR^{84}$ ,  $-NR^{85}R^{86}$ ,  $-CONR^{87}R^{88}$ ,  $-SO_2R^{89}$ ,  $-SO_2NR^{90}R^{91}$ ,  $-NR^{92}CONR^{93}R^{94}$ ,  $-NR^{95}CO_2R^{96}$ ,  $-COR^{97}$ ,  $-NR^{98}COR^{99}$  or  $-NR^{100}SO_2R^{101}$ ; and  $R^{81}$ ,  $R^{82}$ ,  $R^{83}$ ,  $R^{84}$ ,  $R^{85}$ ,  $R^{86}$ ,  $R^{87}$ ,  $R^{88}$ ,  $R^{89}$ ,  $R^{90}$ ,  $R^{91}$ ,  $R^{92}$ ,  $R^{93}$ ,  $R^{94}$ ,  $R^{95}$ ,  $R^{96}$ ,  $R^{97}$ ,  $R^{98}$ ,  $R^{99}$ ,  $R^{100}$  and  $R^{101}$  each independently represents a hydrogen atom, an aliphatic group or an aromatic group.

[0041]

In the formula (II) above,  $R^1$  is preferably a hydrogen atom, an aliphatic group, an aromatic group,  $-OR^{11}$ ,  $-SR^{12}$ ,  $-NR^{15}R^{16}$ ,  $-SO_2R^{19}$ ,  $-NR^{22}CONR^{23}R^{24}$ ,  $-NR^{25}CO_2R^{26}$ ,  $-NR^{28}COR^{29}$  or  $-NR^{30}SO_2R^{31}$ , more preferably a hydrogen atom, an aliphatic group, an aromatic group,  $-OR^{11}$  or  $-NR^{15}R^{16}$ , further preferably a hydrogen atom, an alkyl group, a substituted alkyl group, an aryl group, a substituted aryl group, an alkoxy group, a substituted alkoxy group, a phenoxy group, a substituted phenoxy group, a dialkylamino group or a substituted dialkylamino group, particularly preferably a hydrogen atom, a  $C_{1-10}$  alkyl group, a  $C_{1-10}$  substituted alkyl group, a  $C_{6-10}$  aryl group or a  $C_{6-10}$  substituted aryl group and most preferably a hydrogen atom, a  $C_{1-6}$  alkyl group or a  $C_{1-6}$  substituted alkyl group.

[0042]

In the formula (II) above, A is preferably  $\text{-NR}^4\text{R}^5$ . D is preferably a group forming a 5-membered nitrogenous heterocyclic ring, and the 5-membered nitrogenous heterocyclic ring is more preferably an imidazole ring, a triazole ring or a tetrazole ring.

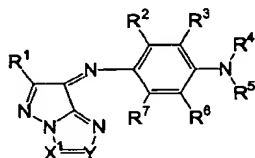
[0043]

Among the compounds represented by the formula (II) above, particularly preferable are oil-soluble pyrazolotriazole azomethine compounds represented by formula (III).

[0044]

[Formula 5]

General formula (III)



[0045]

In the formula (III) above, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup> and R<sup>7</sup> have the same meanings as defined in formula (II) above. One of X<sup>1</sup> and Y represents  $\text{-C(R}^8\text{)=}$  and the other represents  $\text{-N=}$ . R<sup>8</sup> represents a hydrogen atom, an aliphatic group or an aromatic group. It is necessary that one of X<sup>1</sup> and Y is  $\text{-N=}$ . However, X<sup>1</sup> and Y are not simultaneously  $\text{-N=}$ .



[0046]

In the formula (III) above,  $R^8$  is preferably a hydrogen atom, an alkyl group, a substituted alkyl group, an aryl group or a substituted aryl group, more preferably a hydrogen atom, a  $C_{1-150}$  substituted alkyl group or a  $C_{6-150}$  substituted aryl group and most preferably a  $C_{1-100}$  substituted alkyl group or a  $C_{6-100}$  substituted aryl group.

[0047]

Among the compounds represented by formula (III) above, the pyrazolotriazole azomethine compounds wherein  $X^1$  is  $-N=$  and Y is  $-C(R^8)=$  are preferable.

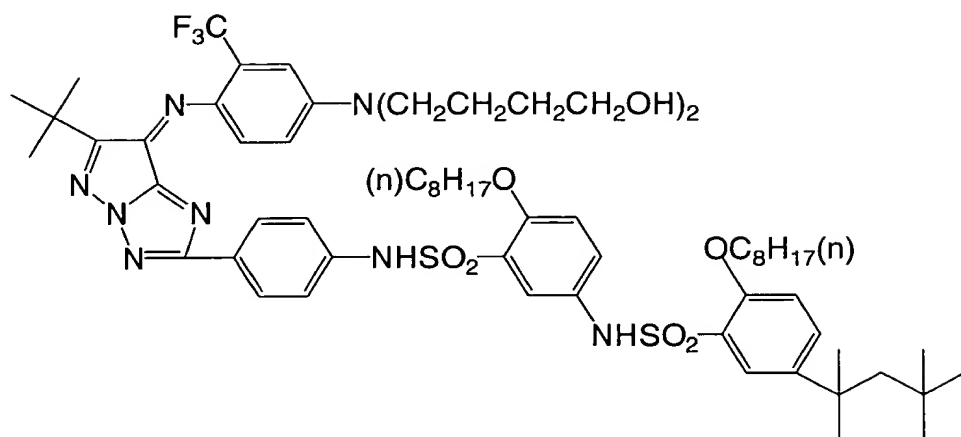
[0048]

The pyrazolotriazole azomethine compounds represented by formula (II) above are shown as the following exemplified compounds (M-1 to M-16) which are not intended to limit the present invention.

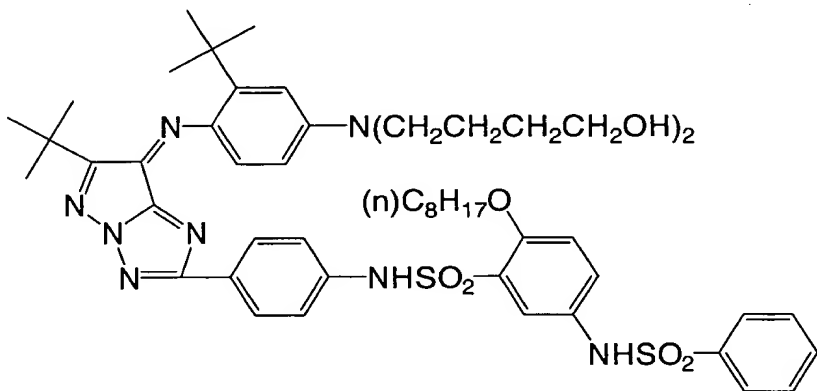
[0049]

[Formula 6]

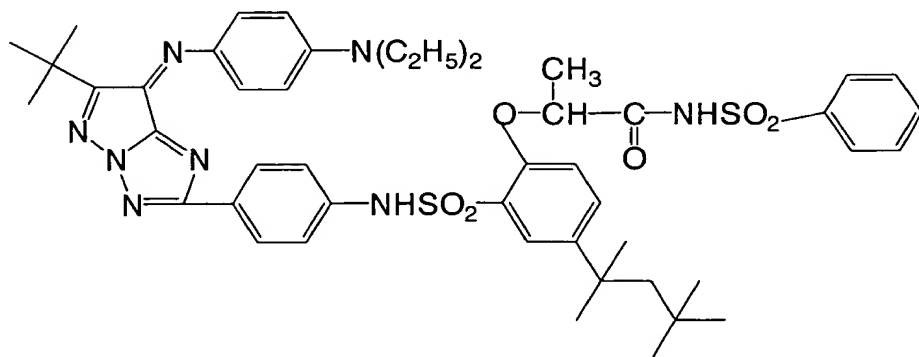
M-1



M-2



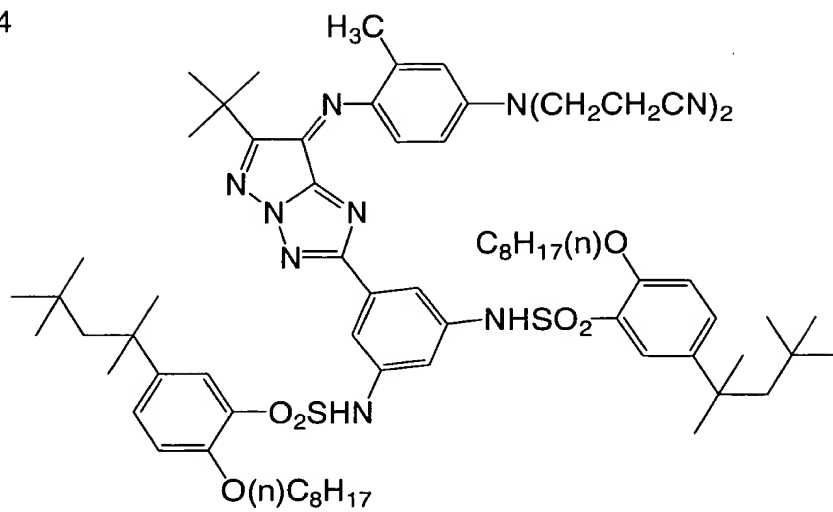
M-3



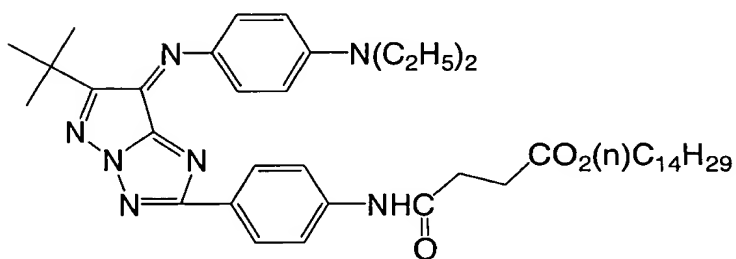
[0050]

[Formula 7]

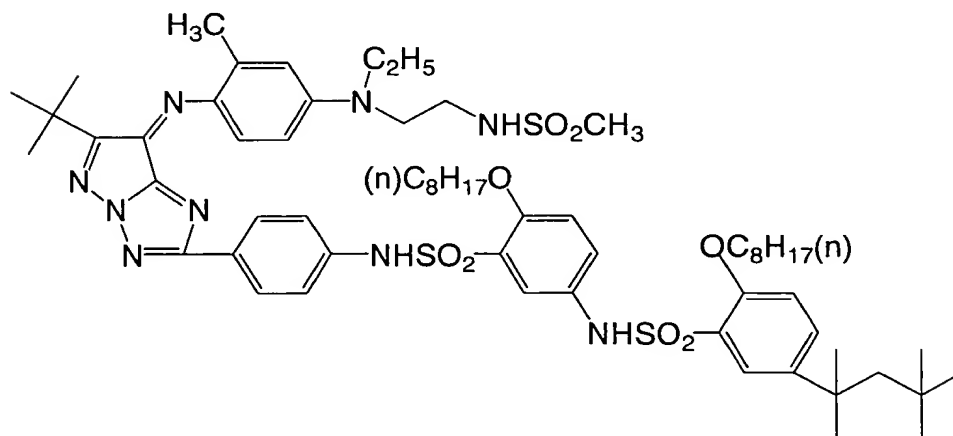
M - 4



M - 5



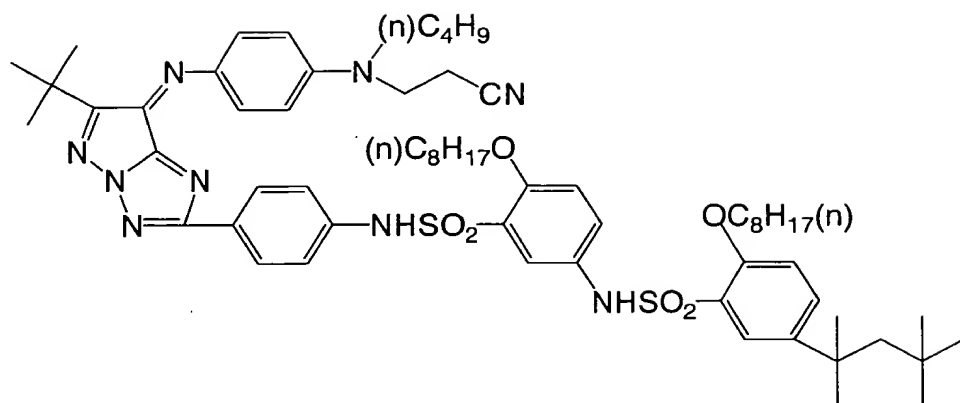
M - 6



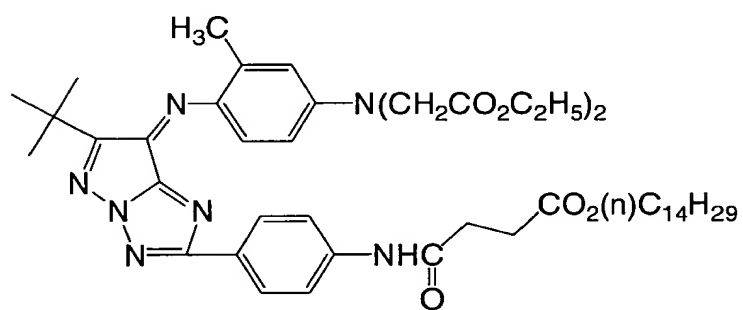
[0051]

[Formula 8]

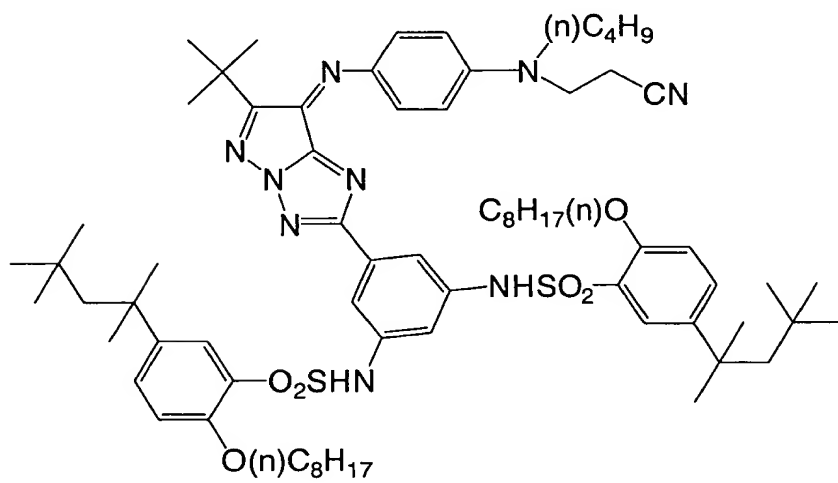
M-7



M-8



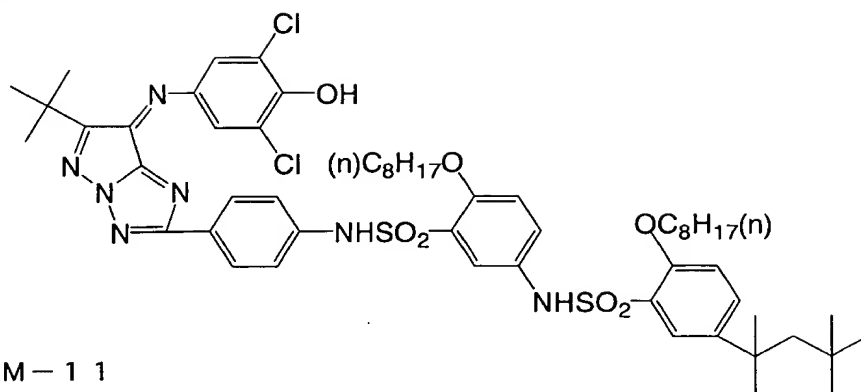
M-9



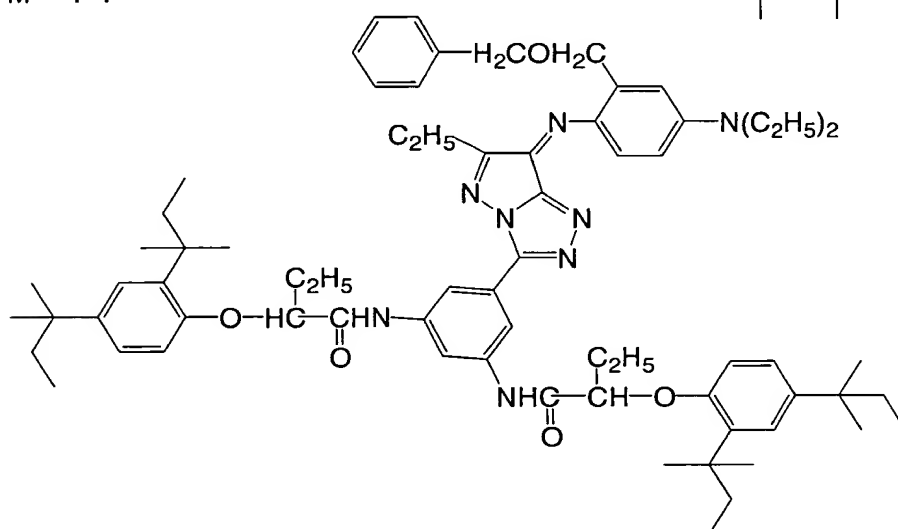
[0052]

[Formula 9]

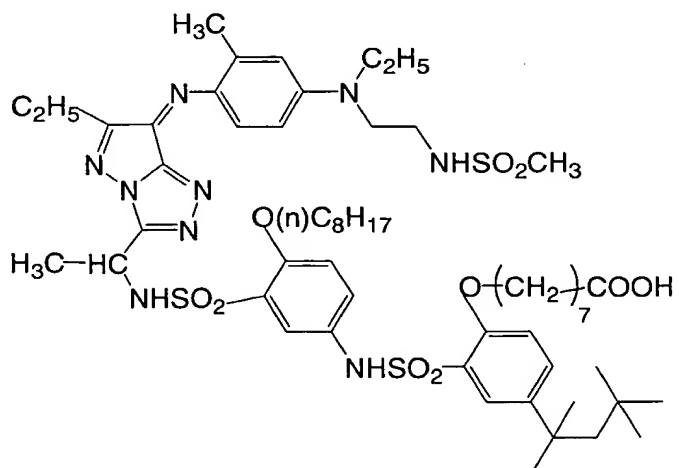
M-10



M-11



M-12



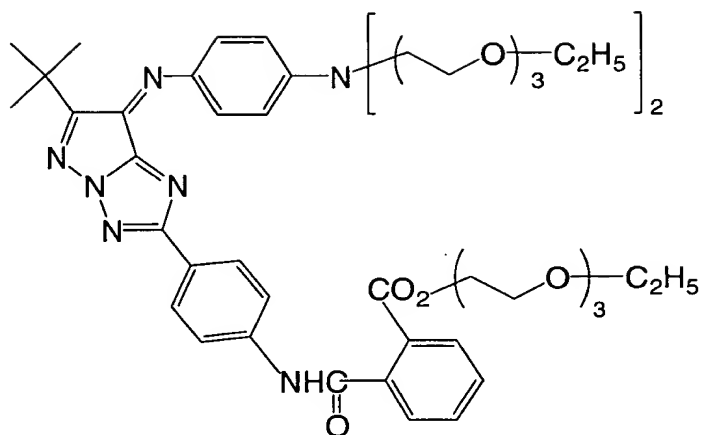
[Formula 10]

CCN(CC)c1ccc(cc1)/N=C2C(=C3C(=N2)N=CN3C4=CC=C(C=C4)C(=O)NCC5=CC=C(C=C5)C(C)(C)CC(C)(C)C)C(C)(C)C(C)(C)CCOc1nc2nc3c(ncn3c2Nc4ccc(NC(=O)C(C)(C)OC5=CC=C(C(C)(C)C)C5)cc4)nc6ccc(N7CCOCC7)cn6CCCCc1nc2nc3nc(NCCNC(=O)C(CCCCCCCCCCCC)Oc4ccc(cc4)S(=O)(=O)c5ccc(cc5)COc6ccccc6)cnc3n2c1CCCC

[0054]

[Formula 11]

M-16



[0055]

The compounds usable in the present invention include, but are not limited to, the exemplified compounds described in Japanese Patent Application No. 2000-78491.

[0056]

The compounds represented by formula (II) above can be synthesized by reference to a method described in e.g. JP-A 4-126772, JP-B 7-94180 and Japanese Patent Application No. 2000-78491.

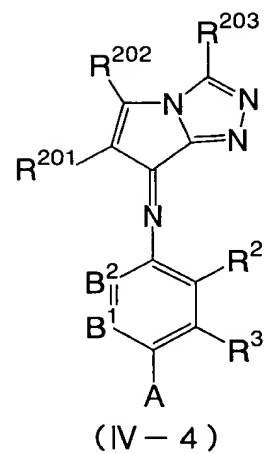
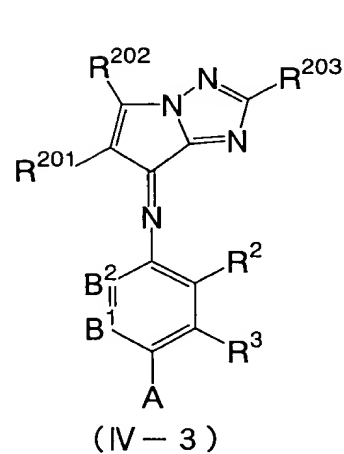
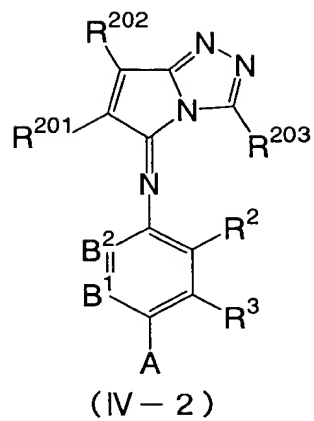
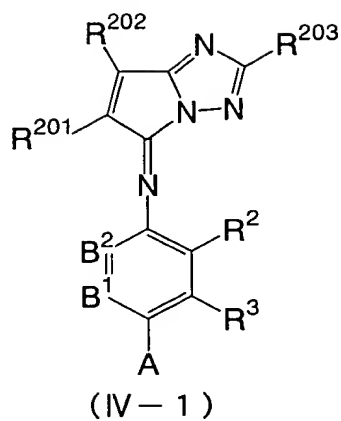
[0057]

As the cyan dyes, the pyrrolotriazole azomethine compounds represented by formulae (IV-1) to (IV-4) below are particularly preferably

used.

[0058]

[Formula 12]



[0059]

In the formulae (IV-1) to (IV-4) above,  $A$ ,  $R^2$ ,  $R^3$ ,  $B^1$  and  $B^2$  have the same meanings as defined in formula (I) above and their preferable scopes are also the same as defined above.  $R^{201}$ ,  $R^{202}$  and  $R^{203}$



independently have the same meanings as those of  $R^1$  defined in formula (II) above.  $R^{201}$  and  $R^{202}$  may be bound to each other to form a ring.

[0060]

Further, pyrrolotriazole azomethine compounds represented by formulae (IV-1) to (IV-4) wherein  $R^{201}$  is an electron attractive group having a Hammett's substituent constant  $\sigma_p$  value of 0.30 or more are more preferable owing to their sharp absorption.

The pyrrolotriazole azomethine compounds wherein the sum of the Hammett's substituent constant  $\sigma_p$  values of  $R^{201}$  and  $R^{202}$  is 0.70 or more are particularly preferable owing to their excellent hue as cyan color.

[0061]

Now, the hues of the pyrrolotriazole azomethine compounds represented by formulae (IV-1) to (IV-4) above are described.

The pyrrolotriazole azomethine compounds represented by formulae (IV-1) to (IV-4) above can have a wide variety of hues depending on the combination of  $R^{201}$ ,  $R^{202}$ ,  $R^{203}$ ,  $R^2$ ,  $R^3$ , A,  $B^1$  and  $B^2$ .

The pyrrolotriazole azomethine compounds represented by formulae (IV-1) to (IV-4) above wherein  $R^{201}$  is an electron attractive substituent group are more preferable owing to their sharper absorption waveform. As the electron attraction of the group is increased, the absorption waveform becomes sharper. In this respect,  $R^{201}$  is preferably an electron attractive group having a Hammett's substituent constant  $\sigma_p$

value of 0.30 or more, more preferably 0.45 or more and most preferably 0.60 or more, rather than an alkyl or aryl group.

[0062]

The pyrrolotriazole azomethine compounds can be used not only as magenta dyes but also as cyan dyes, and they are used more preferably as cyan dyes. The pyrrolotriazole azomethine compounds represented by formulae (IV-1) to (IV-4) above can also be used as magenta dyes.

When the pyrrolotriazole azomethine compounds represented by formulae (IV-1) to (IV-4) above are used as cyan compounds, the sum of the Hammett's substituent constant  $\sigma_p$  values of  $R^{201}$  and  $R^{202}$  is preferably 0.70 or more. A sum of  $\sigma_p$  values of less than 0.70 is not preferable because the absorption maximum wavelength is too short a wavelength for the cyan dye and the dye seems blue to human eyes. In particular, the compounds wherein the Hammett's substituent constant  $\sigma_p$  value of  $R^{202}$  is 0.30 or more are more preferable. In addition, the compounds wherein the sum of the Hammett's substituent constant  $\sigma_p$  values of  $R^{201}$  and  $R^{202}$  is 2.0 or less are preferable.

[0063]

The electron attractive groups having a Hammett's substituent constant  $\sigma_p$  value of 0.30 or more include, e.g., an acyl group, acyloxy group, carbamoyl group, alkoxycarbonyl group, aryloxy carbonyl group, cyano group, nitro group, alkyl sulfonyl group, aryl sulfinyl group, alkyl

sulfonyl group, aryl sulfonyl group, sulfamoyl group, halogenated alkyl group, halogenated alkoxy group, halogenated aryloxy group and halogenated alkylthio group, as well as an aryl or heterocyclic group substituted with two or more electron attractive groups having a  $\sigma_p$  value of 0.15 or more.

[0064]

More specifically, mention can be made of an acyl group (e.g., acetyl, 3-phenylpropanoyl, etc.), acyloxy group (e.g., acetoxy, etc.), carbamoyl group [e.g., N-ethylcarbamoyl, N,N-dibutylcarbamoyl, N-(2-dodecyloxyethyl) carbamoyl, N-methyl-N-dodecylcarbamoyl, etc.], alkoxycarbonyl group (e.g., methoxycarbamoyl, butyloxycarbonyl, dodecyloxycarbonyl, octadecyloxycarbonyl, etc.), aryloxycarbonyl group (e.g., phenoxycarbonyl, etc.), cyano group, nitro group, alkyl sulfinyl group (e.g., 3-phenoxypropyl sulfinyl, etc.), aryl sulfinyl group (e.g., 3-pentadecyl phenyl sulfinyl, etc.), alkyl sulfonyl group (e.g., methane sulfonyl, octane sulfonyl, etc.), aryl sulfonyl group (e.g., benzene sulfonyl, etc.), sulfamoyl group (e.g., N-ethyl sulfamoyl, N,N-dipropyl sulfamoyl, etc.), halogenated alkyl group (e.g., trichloromethyl, heptachloropropyl, etc.), halogenated alkoxy group (e.g., trichloromethyloxy, etc.), halogenated aryloxy group (e.g., pentachlorophenyloxy, etc.), halogenated alkylthio group (e.g., difluoromethylthio, etc.), aryl group substituted with two or more electron-attracting group having a  $\sigma_p$  value of 0.15 or more (e.g., 2,4-dinitrophenyl, 2,4,6-trichlorophenyl, pentachlorophenyl, etc.), heterocyclic group (e.g., 2-benzoxazolyl, 2-

benzothiazolyl, 1-phenyl-2-benzimidazolyl, 5-chloro-1-tetrazolyl, 1-pyrrolyl, etc.).

[0065]

The electron attractive group having a Hammett's substituent constant  $\sigma_p$  value of 0.45 or more includes an acyl group (e.g., acetyl, 3-phenylpropanoyl, etc.), alkoxycarbonyl group (e.g., methoxycarbonyl, etc.), aryloxy carbonyl group (e.g., m-chlorophenoxycarbonyl, etc.), cyano group, nitro group, alkyl sulfinyl group (e.g., n-propyl sulfinyl, etc.), aryl sulfinyl group (e.g. phenyl sulfinyl, etc.), alkyl sulfonyl group (e.g., methane sulfonyl, n-octane sulfonyl, etc.), aryl sulfonyl group (e.g., benzene sulfonyl, etc.), sulfamoyl group (e.g., N-ethylsulfamoyl, N,N-dimethylsulfamoyl, etc.), halogenated alkyl group (e.g., trifluoromethyl, etc.), etc.

[0066]

The electron attractive group having a Hammett's substituent constant  $\sigma_p$  value of 0.60 or more includes a cyano group (0.66), nitro group (0.78), methane sulfonyl group (0.72), etc.

[0067]

The combination of  $R^{201}$  and  $R^{202}$  having a Hammett's substituent constant  $\sigma_p$  value of 0.70 or more in total is preferably a combination of an  $R^{201}$  selected from a cyano group, alkoxy carbonyl group, alkyl sulfonyl group, aryl sulfonyl group and halogenated alkyl group, and an  $R^{202}$

selected from an acyl group, acyloxy group, carbamoyl group, alkoxy carbonyl group, aryloxy carbonyl group, cyano group, alkyl sulfonyl group, aryl sulfonyl group, sulfamoyl group and halogenated alkyl group.

[0068]

Preferable structures of the pyrrolotriazole azomethine compounds in the present invention are those compounds represented by formula (IV-1a) below wherein  $R^2$  represents a hydrogen atom, a  $C_{1-4}$  alkyl group, a  $C_{1-4}$  substituted alkyl group, a halogen atom (fluorine, chlorine, bromine), a  $C_{1-5}$  acylamino group, a  $C_{1-5}$  aminocarbonyl amino group or a  $C_{2-5}$  alkoxy carbonyl amino group,  $R^4$  and  $R^5$  each independently represents a hydrogen atom, a  $C_{1-18}$  alkyl group or a  $C_{1-18}$  substituted alkyl group,  $R^{201}$  and  $R^{202}$  each independently represents an electron attractive group having a Hammett's substituent constant  $\sigma_p$  value of 0.30 or more in total, and  $R^{203}$  represents a  $C_{1-18}$  alkyl group, a  $C_{1-18}$  substituted alkyl group or a  $C_{6-20}$  substituted or unsubstituted aryl group.

[0069]

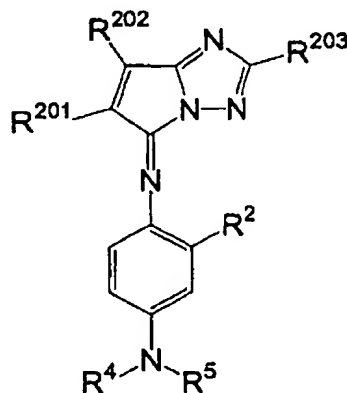
When the pyrrolotriazole azomethine compounds are used as cyan dyes, the preferable structures described above are more preferably those wherein the sum of the Hammett's substituent constant  $\sigma_p$  values of  $R^{201}$  and  $R^{202}$  is 0.70 or more, particularly 1.00 or more.

The pyrrolotriazole azomethine compounds in the present

invention are most preferably those compounds represented by formula (IV-1a) below wherein  $R^2$  represents a hydrogen atom or a methyl group,  $R^4$  and  $R^5$  each independently represents a  $C_{1-5}$  alkyl group,  $R^{201}$  represents a cyano group,  $R^{202}$  represents an alkoxy carbonyl group and  $R^{203}$  represents an aryl group.

[0070]

[Formula 13]



(IV-1 a)

[0071]

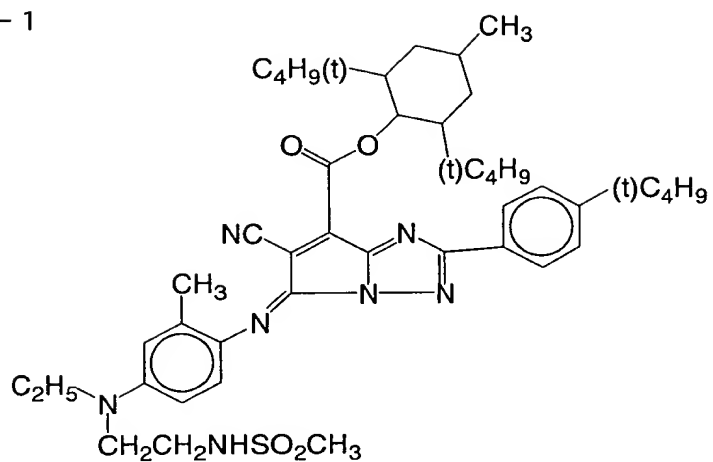
The Hammett's substituent constant used in this specification is described in Japanese Patent Application No. 11-365188, and the  $\sigma_p$  value in the present invention has the same meanings as defined therein.

[0072]

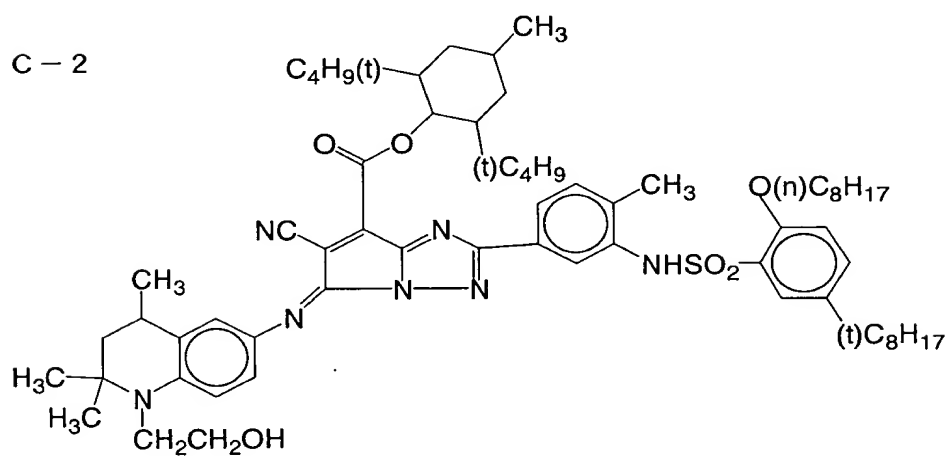
The pyrrolotriazole azomethine compounds in the present invention are shown as the following exemplified compounds (C-1 to C-9) which are not intended to limit the present invention.

[Formula 14]

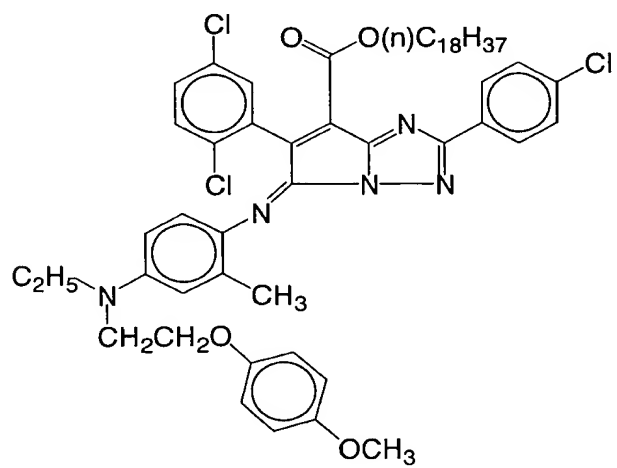
C - 1



C - 2



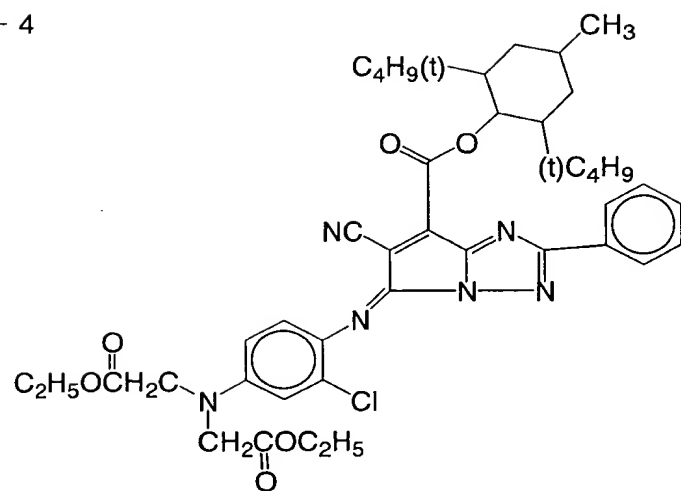
C - 3



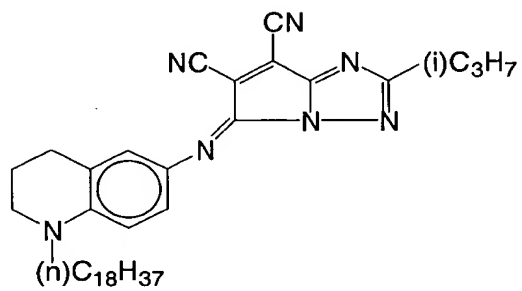
[0074]

[Formula 15]

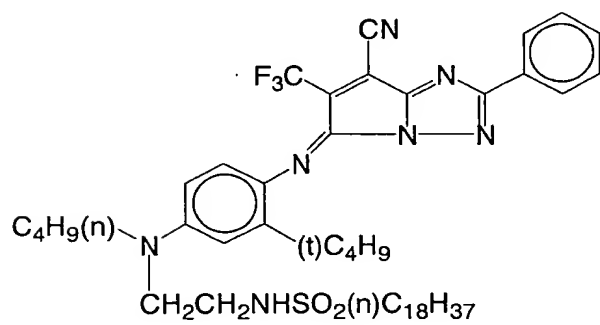
C - 4



C - 5



C - 6

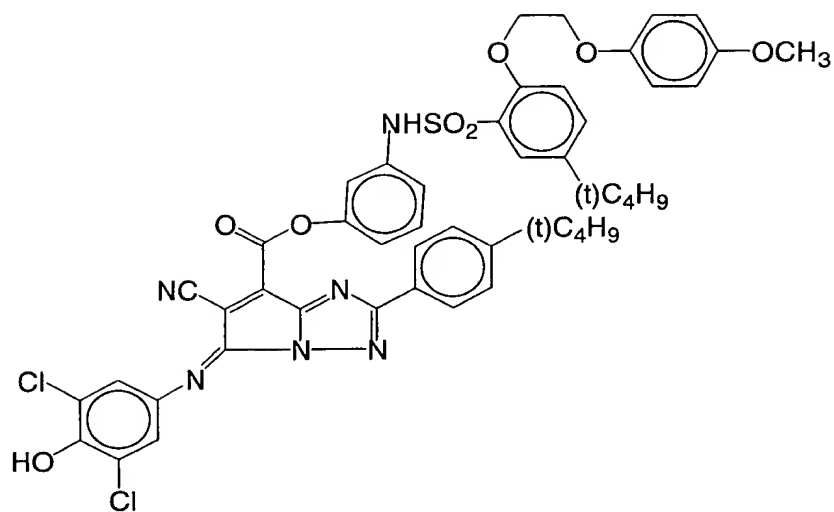




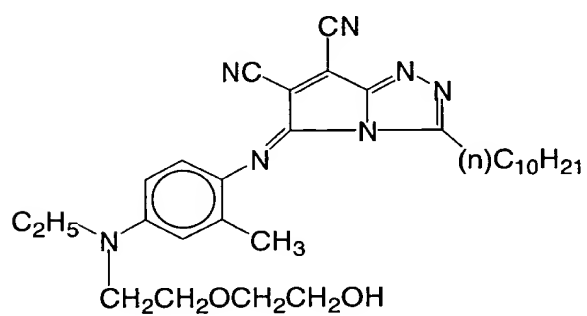
[0075]

[Formula 16]

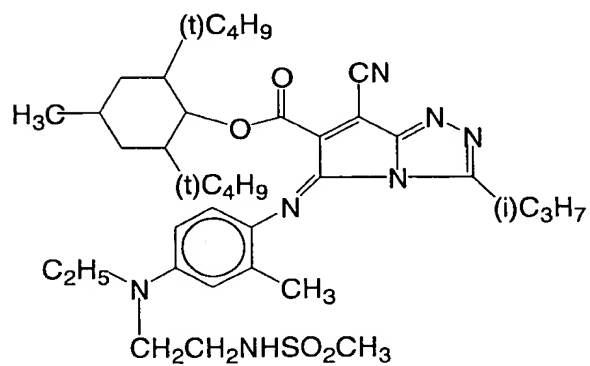
C - 7



C - 8



C - 9



[0076]

The compounds usable in the present invention include, but are not limited to, those compounds exemplified in Japanese Patent Application No. 11-365188.

[0077]

The pyrrolotriazole azomethine compounds represented by formulae (IV-1) to (IV-4) above can be synthesized by reference to the methods described in JP-A 5-177959, JP-A 9-292679, JP-A 10-62926 and Japanese Patent Application No. 11-365188.

[0078]

- Hydrophobic High-boiling Organic Solvent -

In the present invention, the colored fine particle contains the hydrophobic high-boiling organic solvent. The hydrophobic high-boiling organic solvent is hydrophobic and its boiling point is 150 °C or more. As used herein, the term “hydrophobic” refers to 3 % or less solubility in distilled water at 25 °C. The boiling point of the hydrophobic high-boiling organic solvent is preferably 170 °C or more. The dielectric constant of the hydrophobic high-boiling organic solvent is preferably 3 to 12, more preferably 4 to 10. As used herein, the term “dielectric constant” is indicative of relative dielectric constant under vacuum at 25 °C.

[0079]

The hydrophobic high-boiling organic solvent is not particularly

limited and can be selected as necessary. For example, the compounds described in US Patent No. 2,322,027, etc. can be mentioned, and hydrophobic high-boiling organic solvents based on phosphates, fatty acid esters, phthalates, benzoates, phenols or amides are preferable.

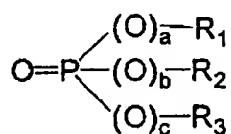
[0080]

The hydrophobic high-boiling organic solvent is particularly preferably those compounds represented by formulae [S-1] to [S-9]:

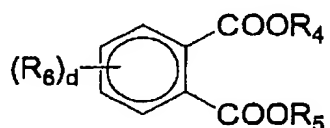
[0081]

[Formula 17]

Formula [S-1]



Formula [S-2]



Formula [S-3]



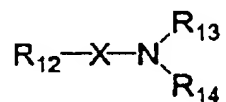
Formula [S-4]



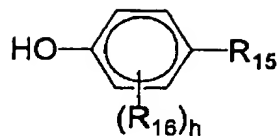
Formula [S-5]



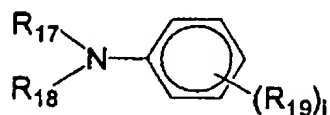
Formula [S-6]



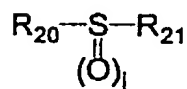
Formula [S-7]



Formula [S-8]



Formula [S-9]



[0082]

In formula [S-1] above,  $R_1$ ,  $R_2$  and  $R_3$  each independently represents an aliphatic or aryl group.  $a$ ,  $b$  and  $c$  each independently represents 0 or 1.

[0083]

In formula [S-2] above,  $R_4$  and  $R_5$  each independently represents an aliphatic or aryl group.

$R_6$  represents a halogen atom (here and hereinafter F, Cl, Br, or I), an alkyl group, an alkoxy group, an aryloxy group, an alkoxycarbonyl group or an aryloxycarbonyl group.

$d$  is an integer of 0 to 3. When  $d$  is two or more, a plurality of  $R_6$  groups may be the same or different.

[0084]

In formula [S-3] above, Ar represents an aryl group.  $e$  is an integer

of 1 to 6.  $R_7$  represents an e-valent hydrocarbon group or groups, the groups being bound to each other via ether linkage.

[0085]

In formula [S-4] above,  $R_8$  represents an aliphatic group.  $f$  is an integer of 1 to 6.  $R_9$  represents an f-valent hydrocarbon group or groups, the groups bound to each other via ether linkage.

[0086]

In formula [S-5] above,  $g$  is an integer of 2 to 6.  $R_{10}$  represents a  $g$ -valent hydrocarbon group (excluding an aryl group).  $R_{11}$  represents an aliphatic group or an aryl group.

[0087]

In formula [S-6] above,  $R_{12}$ ,  $R_{13}$  and  $R_{14}$  each independently represents a hydrogen atom, an aliphatic group or an aryl group.  $X$  represents  $-\text{CO}-$  or  $\text{SO}_2-$ .  $R_{12}$  and  $R_{13}$ , or  $R_{13}$  and  $R_{14}$ , may be bound to each other to form a ring.

[0088]

In formula [S-7] above,  $R_{15}$  represents an aliphatic group, an alkoxycarbonyl group, an aryloxycarbonyl group, an alkylsulfonyl group, an arylsulfonyl group, an aryl group or a cyano group.

$R_{16}$  represents a halogen atom, an aliphatic group, an aryl group, an alkoxy group or an aryloxy group.

h is an integer of 0 to 3. When h is two or more, a plurality of R<sub>16</sub> groups may be the same or different.

[0089]

In formula [S-8] above, R<sub>17</sub> and R<sub>18</sub> each independently represents an aliphatic group or an aryl group. R<sub>19</sub> represents a halogen atom, an aliphatic group, an aryl group, an alkoxy group or an aryloxy group. i is an integer of 0 to 4. When i is two or more, a plurality of R<sub>19</sub> groups may be the same or different.

[0090]

In formula [S-9] above, R<sub>20</sub> and R<sub>21</sub> represent an aliphatic group or an aryl group. j is 1 or 2.

[0091]

In the formulae [S-1] to [S-9] above, when any of R<sub>1</sub> to R<sub>6</sub>, R<sub>8</sub>, and R<sub>11</sub> to R<sub>21</sub> represents an aliphatic group or a group containing an aliphatic group, the aliphatic group may be straight-chain, branched or cyclic, may contain an unsaturated bond, and may have a substituent group. Examples of the substituent group include a halogen atom, aryl group, alkoxy group, aryloxy group, alkoxycarbonyl group, hydroxyl group, acyloxy group, epoxy group, etc.

[0092]

In the formulae [S-1] to [S-9] above, when any of R<sub>1</sub> to R<sub>6</sub>, R<sub>8</sub> and

R<sub>11</sub> to R<sub>21</sub> represents a cyclic aliphatic group (i.e. cycloalkyl group) or a group containing a cycloalkyl group, the cycloalkyl group may contain an unsaturated bond in the 3- to 8-membered ring thereof, or may have a substituent group or a crosslinking group. Examples of the substituent group include a halogen atom, aliphatic group, hydroxyl group, acyl group, aryl group, alkoxy group, epoxy group, alkyl group, etc., and examples of the crosslinking group include a methylene group, ethylene group, isopropylidene group, etc.

[0093]

In the formulae [S-1] to [S-9] above, when any of R<sub>1</sub> to R<sub>6</sub>, R<sub>8</sub>, and R<sub>11</sub> to R<sub>21</sub> represents an aryl group or a group containing an aryl group, the aryl group may be substituted with a halogen atom, aliphatic group, aryl group, alkoxy group, aryloxy group, alkoxycarbonyl group, etc.

[0094]

In the formulae [S-3], [S-4] and [S-5] above, when R<sub>7</sub>, R<sub>9</sub> or R<sub>10</sub> is a hydrocarbon group, the hydrocarbon group may contain a cyclic structure (e.g. a benzene ring, a cyclopentane ring, a cyclohexane ring) or an unsaturated bond or may have a substituent group. Examples of the substituent group include a halogen atom, hydroxyl group, acyloxy group, aryl group, alkoxy group, aryloxy group, epoxy group, etc.

[0095]

Now, particularly preferable hydrophobic high-boiling organic

solvents in the present invention are described.

[0096]

In the formula [S-1] above,  $R_1$ ,  $R_2$  and  $R_3$  each represent a  $C_{1-24}$  (preferably  $C_{4-18}$ ) aliphatic group (e.g., n-butyl, 2-ethylhexyl, 3,3,5-trimethylhexyl, n-dodecyl, n-octadecyl, benzyl, oleyl, 2-chloroethyl, 2,3-dichloropropyl, 2-butoxyethyl, 2-phenoxyethyl, cyclopentyl, cyclohexyl, 4-t-butylcyclohexyl, or 4-methylcyclohexyl) or a  $C_{6-24}$  (preferably  $C_{6-18}$ ) aryl group (e.g., phenyl, cresyl, p-nonylphenyl, xylyl, cumenyl, p-methoxyphenyl, or p-methoxycarbonylphenyl).

a, b and c are independently 0 or 1, and preferably all of them are 1.

[0097]

In the formula [S-2] above,  $R_4$  and  $R_5$  each represents a  $C_{1-24}$  (preferably  $C_{4-18}$ ) aliphatic group (e.g., the same alkyl group as exemplified for  $R_1$  above, ethoxycarbonyl methyl, 1,1-diethylpropyl, 2-ethyl-1-methylhexyl, cyclohexylmethyl, 1-ethyl-1,5-dimethylhexyl, 3,5,5-trimethylcyclohexyl, or 1-methylcyclohexyl) or a  $C_{6-24}$  (preferably  $C_{6-18}$ ) aryl group (e.g., the same aryl group as exemplified for  $R_1$  above, 4-t-butylphenyl, 4-t-octylphenyl, 1,3,5-trimethylphenyl, or 2,4-di-t-butylphenyl, 2,4-di-t-pentylphenyl).

$R_6$  is a halogen atom (preferably Cl), a  $C_{1-18}$  alkyl group (e.g., methyl, isopropyl, t-butyl, n-dodecyl), a  $C_{1-18}$  alkoxy group (e.g., methoxy, n-butoxy, n-octyloxy, methoxyethoxy, benzyloxy), a  $C_{6-18}$  aryloxy group





[0100]

or e-valent  $C_{4-24}$  (preferably  $C_{4-18}$ ) hydrocarbon groups bound to each other via an ether linkage (for example,  $-\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2-$ ,  $-\text{CH}_2\text{CH}_2(\text{OCH}_2\text{CH}_2)_3-$ ,  $-\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_2-$ , and the following groups:

[0101]

[Formula 19]



[0102]

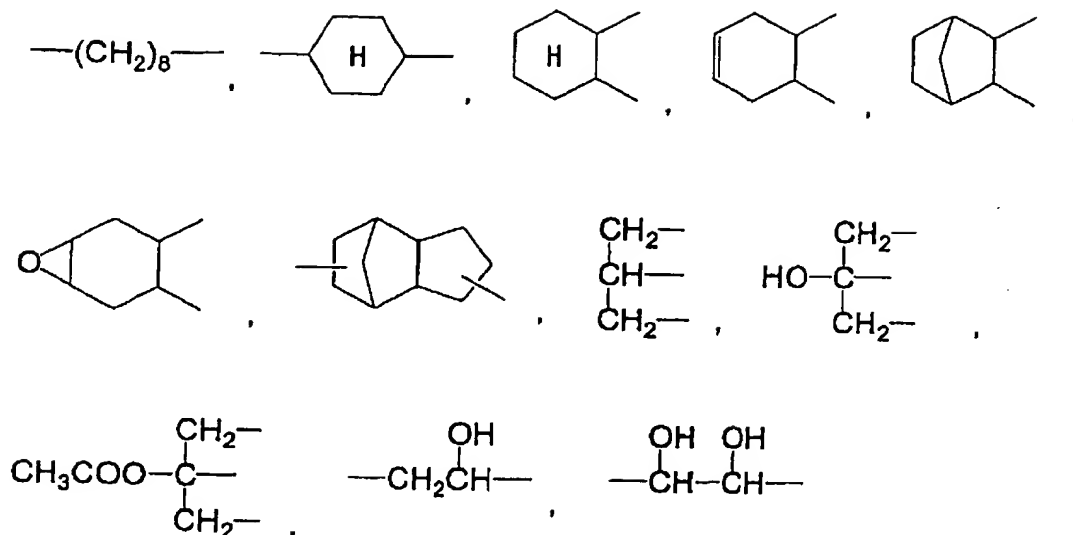
In formula [S-4] above,  $R_8$  is a  $C_{3-24}$  (preferably  $C_{3-17}$ ) aliphatic group (e.g. n-propyl, 1-hydroxyethyl, 1-ethylpentyl, n-undecyl, pentadecyl, 8,9-epoxyheptadecyl, cyclopropyl, cyclohexyl, or 4-methylcyclohexyl),  $f$  is an integer of 1 to 4 (preferably 1 to 3), and  $R^9$  is an  $f$ -valent  $C_{2-24}$  (preferably  $C_{2-18}$ ) hydrocarbon group or “c”-valent  $C_{4-24}$  (preferably  $C_{4-18}$ ) hydrocarbon groups bound to each other via an ether linkage (e.g., the same group exemplified for  $R_7$  above).

[0103]

In the formula [S-5] above,  $g$  is 2 to 4 (preferably 2 or 3), and  $R_{10}$  is a  $g$ -valent hydrocarbon group (e.g.,  $-\text{CH}_2-$ ,  $-(\text{CH}_2)_2-$ ,  $-(\text{CH}_2)_4-$ ,  $-(\text{CH}_2)_7-$ , and the following groups:

[0104]

[Formula 20]



[0105]

$R_{11}$  is a  $C_{1-24}$  (preferably  $C_{4-18}$ ) aliphatic group or a  $C_{6-24}$  (preferably  $C_{6-18}$ ) aryl group (e.g., the same aliphatic or aryl group as exemplified for  $R_4$  above).

[0106]

In the formula [S-6] above,  $R_{12}$  is a  $C_{1-20}$  aliphatic group (e.g., n-propyl, 1-ethylpentyl, n-undecyl, n-pentadecyl, 2,4-di-t-pentylphenoxyethyl, 4-t-octylphenoxyethyl, 3-(2,4-di-t-butylphenoxy)propyl, 1-(2,4-di-t-butylphenoxy)propyl, cyclohexyl, or 4-methylcyclohexyl) or a  $C_{6-24}$  (preferably  $C_{6-18}$ ) aryl group (e.g., the same aryl group exemplified for Ar above).

$R_{13}$  and  $R_{14}$  each represent a  $C_{3-24}$  (preferably  $C_{3-18}$ ) aliphatic group (e.g., isopropyl, n-butyl, n-hexyl, 2-ethylhexyl, n-dodecyl, cyclopentyl,

cyclopropyl) or a C<sub>6-18</sub> (preferably C<sub>6-15</sub>) aryl group (e.g., phenyl, 1-naphthyl, p-tolyl).

R<sub>13</sub> and R<sub>14</sub> may be bound to each other to form a pyrrolidine, piperidine or morpholine ring with N, and R<sub>12</sub> and R<sub>13</sub> may be bound to each other to form a pyrrolidone ring.

X represents -CO- or SO<sub>2</sub>, preferably -CO-.

[0107]

In formula [S-7] above, R<sub>15</sub> is a C<sub>1-24</sub> (preferably C<sub>3-18</sub>) aliphatic group (e.g., methyl, isopropyl, t-butyl, t-pentyl, t-hexyl, t-octyl, 2-butyl, 2-hexyl, 2-octyl, 2-dodecyl, 2-hexadecyl, t-pentadecyl, cyclopentyl, or cyclohexyl), a C<sub>2-24</sub> (preferably C<sub>5-17</sub>) alkoxycarbonyl group (e.g., n-butoxycarbonyl, 2-ethylhexyloxycarbonyl, n-dodecyloxycarbonyl), a C<sub>1-24</sub> (preferably C<sub>3-18</sub>) alkyl sulfonyl group (e.g., n-butyl sulfonyl, n-dodecyl sulfonyl), a C<sub>6-30</sub> (preferably C<sub>6-24</sub>) aryl sulfonyl group (e.g., p-tolyl sulfonyl, p-dodecylphenyl sulfonyl, p-hexadecyloxyphenyl sulfonyl), a C<sub>6-32</sub> (preferably C<sub>6-24</sub>) aryl group (e.g., phenyl, p-tolyl) or a cyano group.

[0108]

R<sub>16</sub> is a halogen atom (preferably Cl), a C<sub>1-24</sub> (preferably C<sub>3-18</sub>) alkyl group (e.g., the same alkyl group as exemplified for R<sub>15</sub> above), a C<sub>5-17</sub> cycloalkyl group (e.g., cyclopentyl, cyclohexyl), a C<sub>6-32</sub> (preferably C<sub>6-24</sub>) aryl group (e.g., phenyl, p-tolyl), a C<sub>1-24</sub> (preferably C<sub>1-18</sub>) alkoxy group (e.g., methoxy, n-butoxy, 2-ethylhexyloxy, benzyloxy, n-dodecyloxy, n-hexadecyloxy) or a C<sub>6-32</sub> (preferably C<sub>6-24</sub>) aryloxy group (e.g., phenoxy, p-

t-butylphenoxy, p-t-octylphenoxy, m-pentadecylphenoxy, p-decyloxyphenoxy), and h is an integer of 1 to 2.

[0109]

In formula [S-8] above,  $R_{17}$  and  $R_{18}$  have the same meanings as defined for  $R_{13}$  and  $R_{14}$  above, and  $R_{19}$  has the same meanings as defined for  $R_{16}$  above.

[0110]

In formula [S-9] above,  $R_{20}$  and  $R_{21}$  have the same meanings as defined for  $R_1$ ,  $R_2$  and  $R_3$  above, and j is 1 or 2, preferably 1.

[0111]

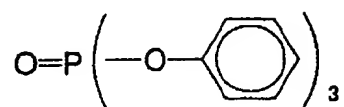
Examples of the hydrophobic high-boiling organic solvents (S-1 to S-23 as compounds represented by [S-1] above, S-24 to S-39 as compounds represented by [S-2] above, S-40 to S-44 as compounds represented by [S-3] above, S-45 to S-50 as compounds represented by [S-4] above, S-51 to S-58 as compounds represented by [S-5] above, S-59 to S-67 as compounds represented by [S-6] above, S-68 to S-75 as compounds represented by [S-7] above, S-76 to S-79 as compounds represented by [S-8] above, and S-80 to S-81 as compounds represented by [S-9] above) are shown below.

[0112]

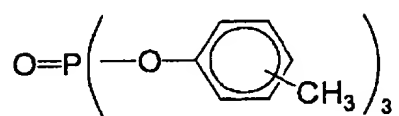
[Formula 21]

Compounds represented by formula [S-1]

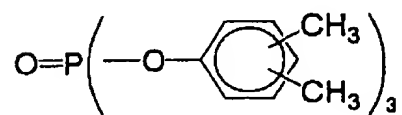
S-1



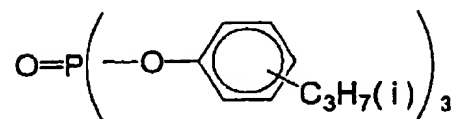
S-2



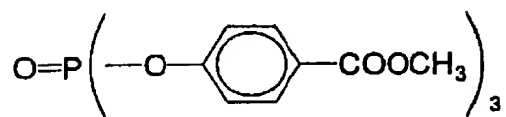
S-3



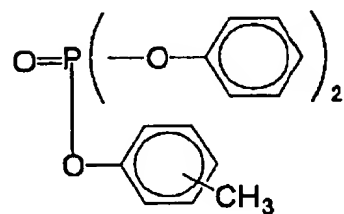
S-4



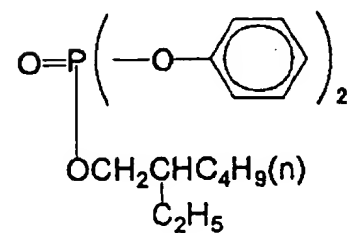
S-5



S-6

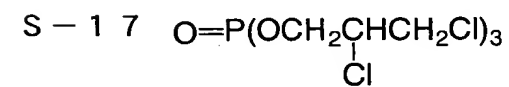
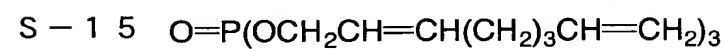
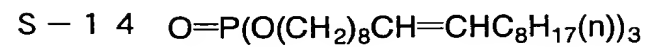
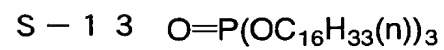
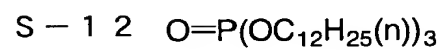
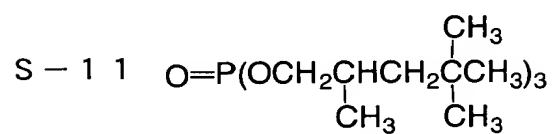
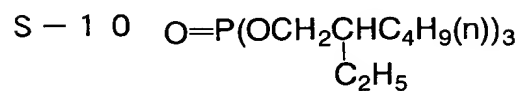
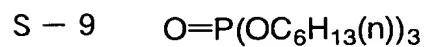
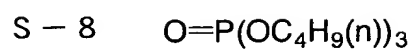


S-7



[0113]

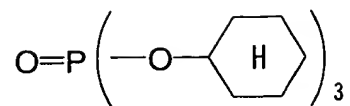
[Formula 22]



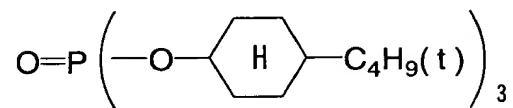
[0114]

[Formula 23]

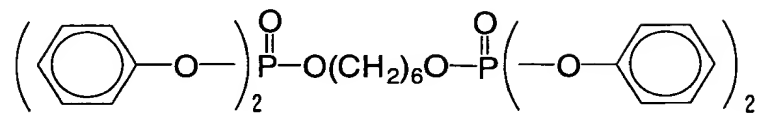
S - 1 8



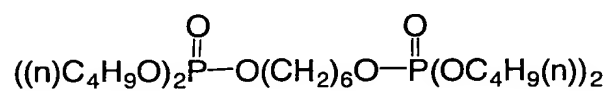
S - 1 9



S - 2 0

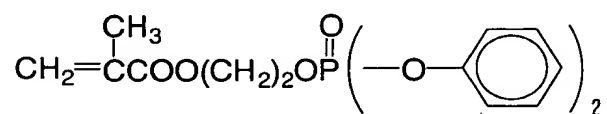


S - 2 1



S - 2 2  $((\text{n})\text{C}_8\text{H}_{17})_3\text{P}=\text{O}$

S - 2 3

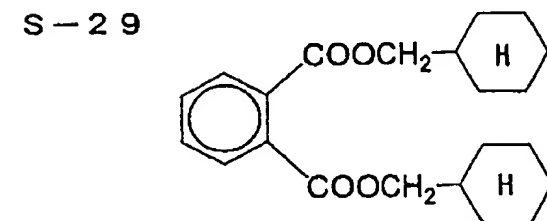
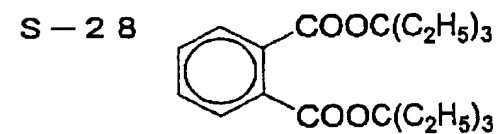
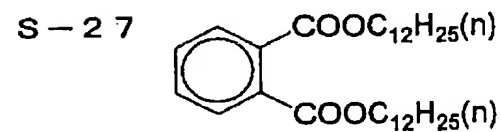
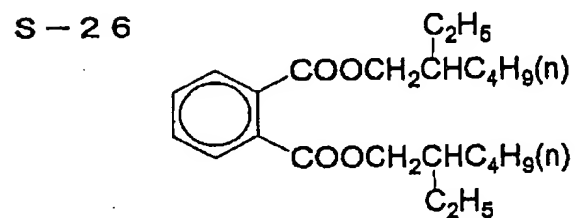
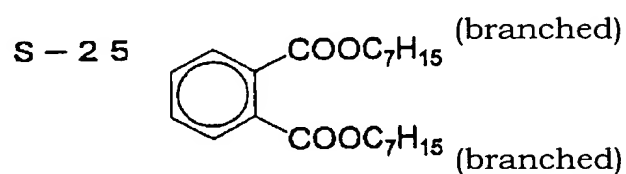
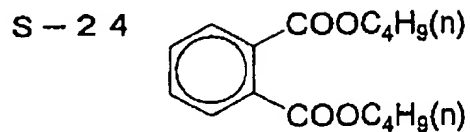




[0115]

[Formula 24]

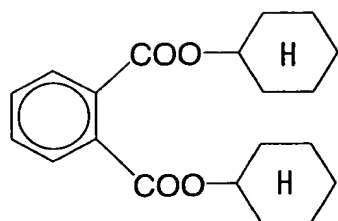
Compounds represented by formula [S-2]



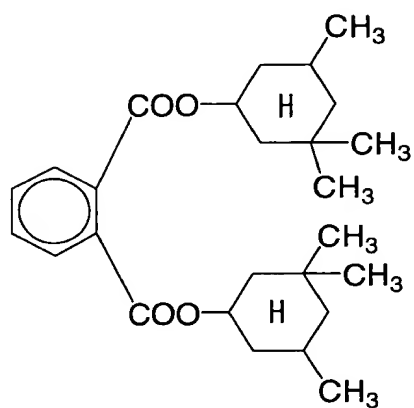
[0116]

[Formula 25]

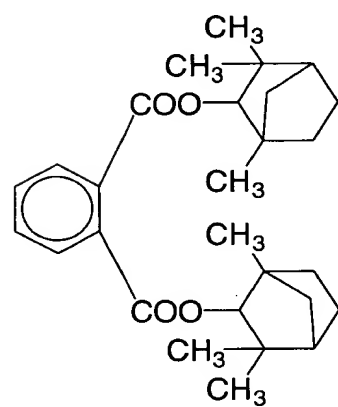
S - 3 0



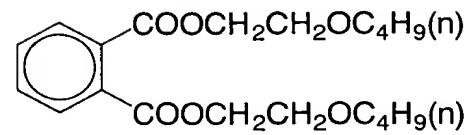
S - 3 1



S - 3 2



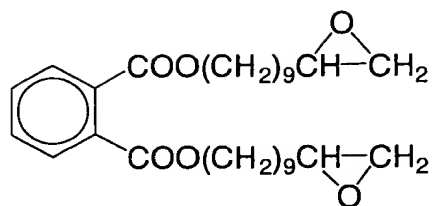
S - 3 3



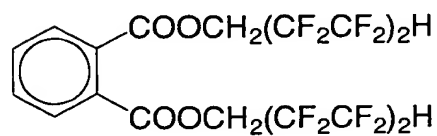
[0117]

[Formula 26]

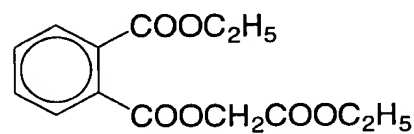
S - 3 4



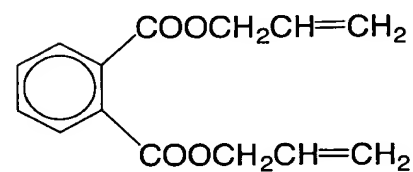
S - 3 5



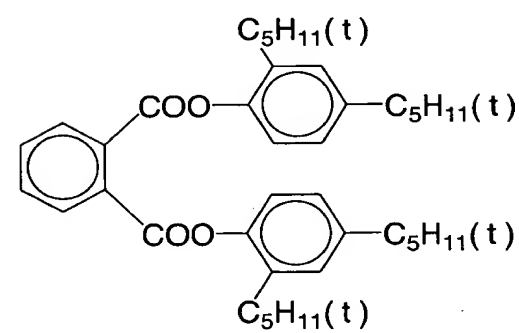
S - 3 6



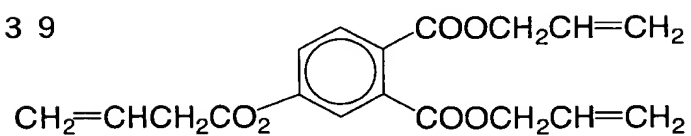
S - 3 7



S - 3 8



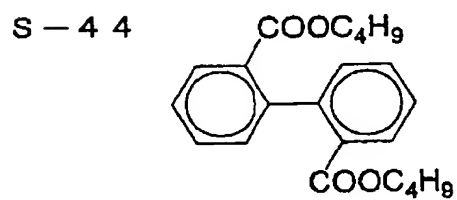
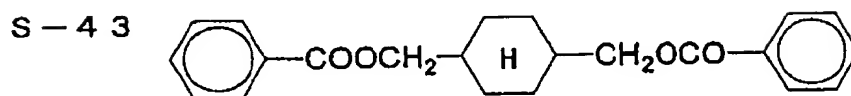
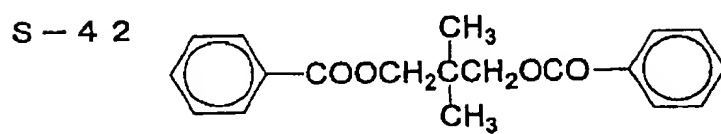
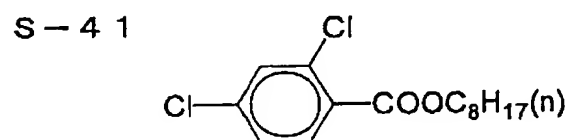
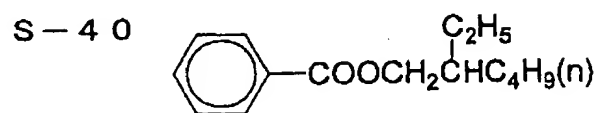
S - 3 9



[0118]

[Formula 27]

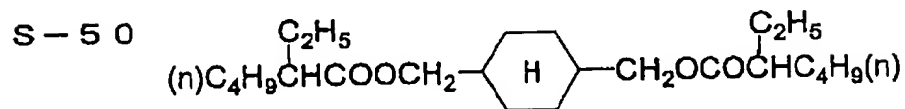
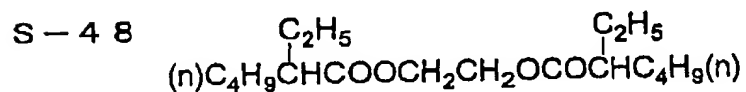
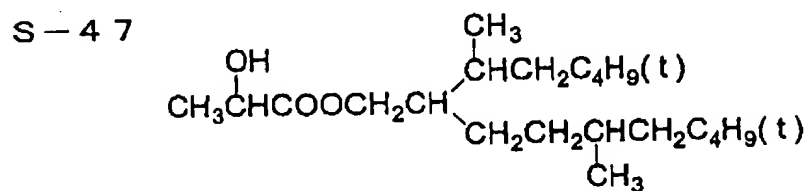
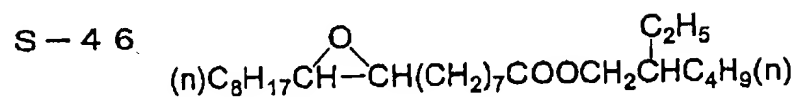
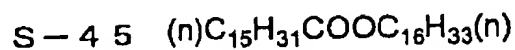
Compounds represented by formula [S-3]



[0119]

[Formula 28]

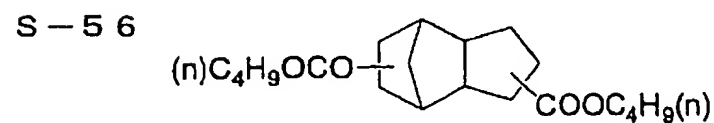
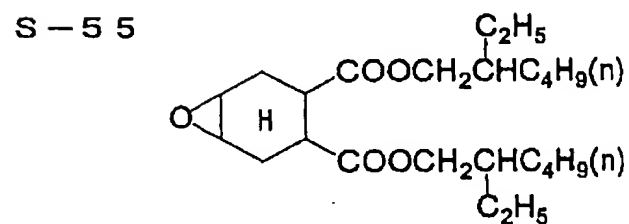
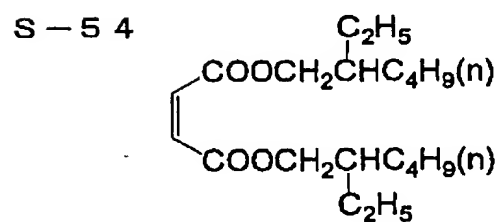
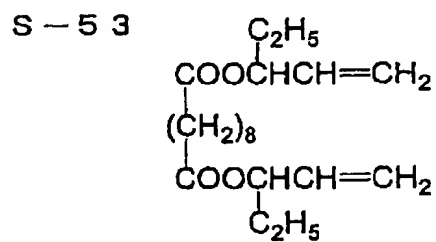
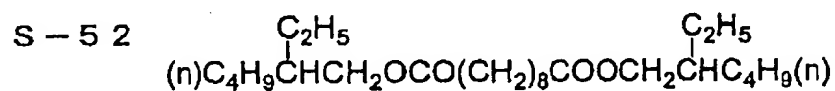
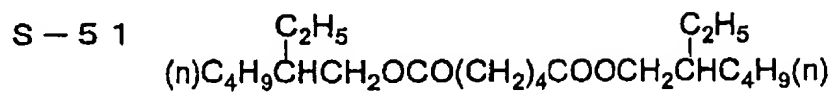
Compounds represented by formula [S-4]



[0120]

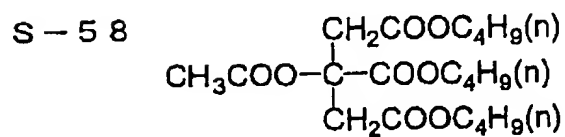
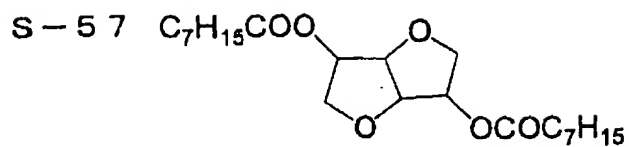
[Formula 29]

Compounds represented by formula [S-5]

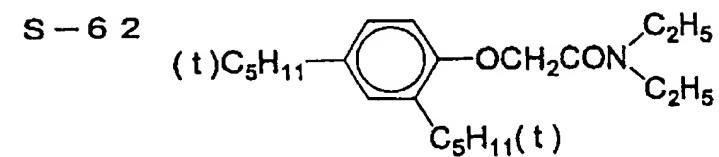
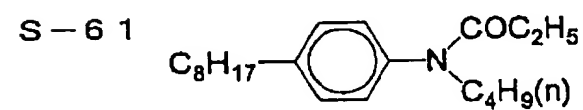
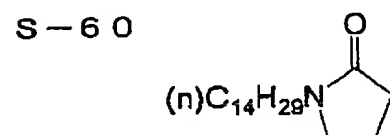
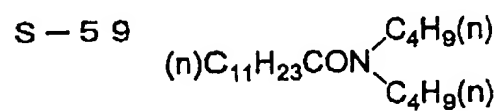


[0121]

[Formula 30]



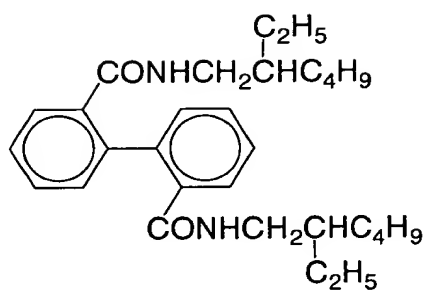
Compounds represented by formula [S-6]



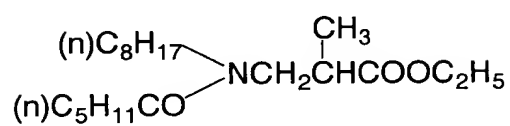
[0122]

[Formula 31]

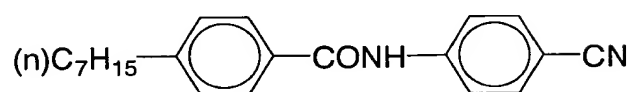
S - 6 3



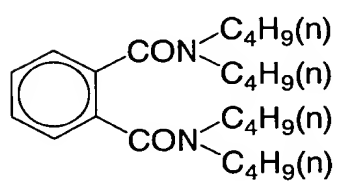
S - 6 4



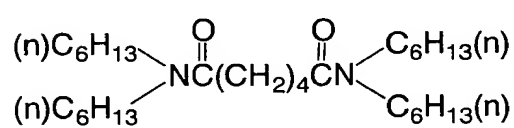
S - 6 5



S - 6 6



S - 6 7



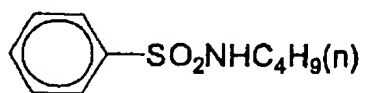


[0123]

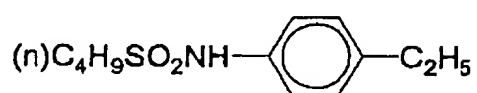
[Formula 32]

Compounds represented by formula [S-7]

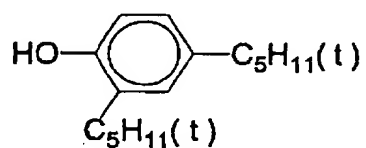
S-68



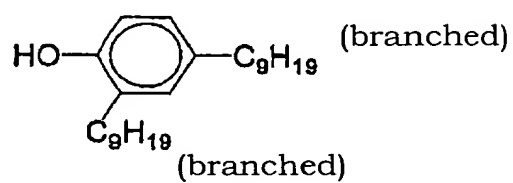
S-69



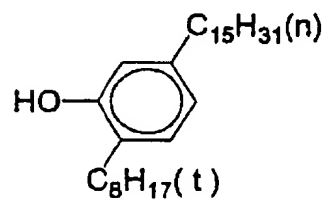
S-70



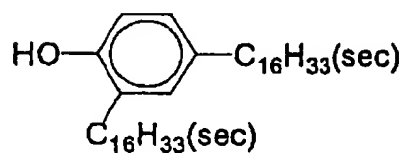
S-71



S-72

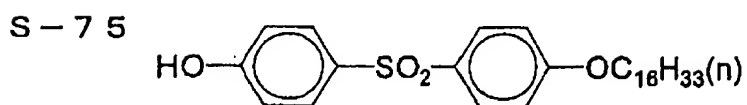
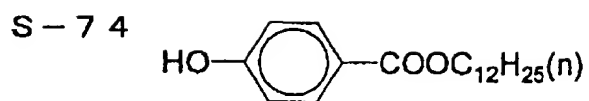


S-73

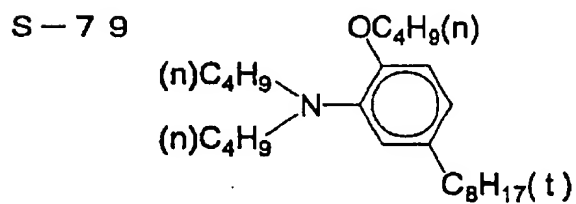
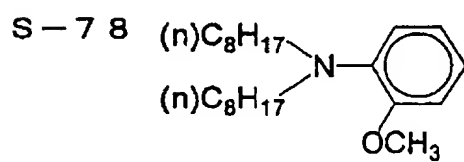
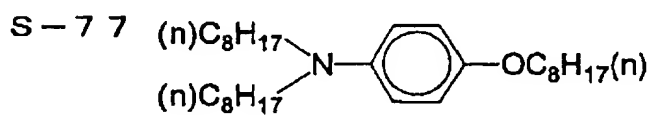
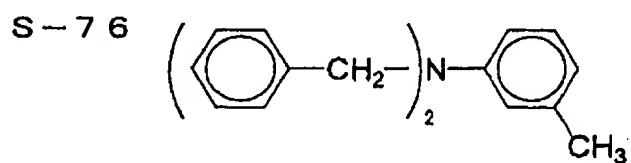


[0124]

[Formula 33]



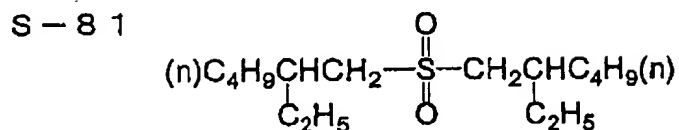
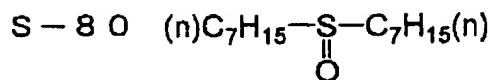
Compounds represented by formula [S-8]



[0125]

[Formula 34]

Compounds represented by formula [S-9]



[0126]

In the present invention, the hydrophobic high-boiling organic solvents may be used singly or in a combination thereof. For example, tricresyl phosphate may be used in combination with dibutyl phthalate, or trioctyl phosphate may be used in combination with di(2-ethylhexyl) sebacate.

[0127]

Examples of hydrophobic high-boiling organic solvents other than those described above and/or methods of synthesizing these hydrophobic high-boiling organic solvents are described in US Patent Nos. 2,322,027, 2,533,514, 2,772,163, 2,835,579, 3,594,171, 3,676,137, 3,689,271, 3,700,454, 3,748,141, 3,764,336, 3,765,897, 3,912,515, 3,936,303, 4,004,928, 4,080,209, 4,127,413, 4,193,802, 4,207,393, 4,220,711, 4,239,851, 4,278,757, 4,353,979, 4,363,873, 4,430,421, 4,430,422, 4,464,464, 4,483,918, 4,540,657, 4,684,606, 4,728,599, 4,745,049, 4,935,321 and 5,013,639, European Patent Nos. 276,319A,

286,253A, 289,820A, 309,158A, 309,159A, 309,160A, 509,311A and 510,576A, East German Patent Nos. 147,009, 157,147, 159,573 and 225,240A, British Patent No. 2,091,124A, JP-A 48-47335, JP-A 50-26530, JP-A 51-25133, JP-A 51-26036, JP-A 51-27921, JP-A 51-27922, JP-A 51-149028, JP-A 52-46816, JP-A 53-1520, JP-A 53-1521, JP-A 53-15127, JP-A 53-146622, JP-A 54-91325, JP-A 54-106228, JP-A 54-118246, JP-A 55-59464, JP-A 56-64333, JP-A 56-81836, JP-A 59-204041, JP-A 61-84641, JP-A 62-118345, JP-A 62-247364, JP-A 63-167357, JP-A 63-214744, JP-A 63-301941, JP-A 64-9452, JP-A 64-9454, JP-A 64-68745, JP-A 1-101543, JP-A 1-102454, JP-A 2-792, JP-A 2-4239, JP-A 2-43541, JP-A 4-29237, JP-A 4-30165, JP-A 4-232946, JP-A 4-346338, etc.

[0128]

- Production of Colored Fine Particle Dispersion -

The colored fine particle dispersion of the present invention comprises colored fine particles containing at least an oil-soluble dye and the hydrophobic high-boiling organic solvent dispersed in an aqueous medium. Specifically, a method of co-emulsification dispersion of the oil-soluble dye and the hydrophobic high-boiling organic solvent (co-emulsification dispersion method) can be mentioned. The emulsification dispersion method is preferably a method of emulsifying an organic solvent phase containing the water-insoluble dye and the hydrophobic high-boiling organic solvent to form fine particles either by addition of water to said organic solvent phase or by addition of said organic solvent

phase to water.

[0129]

The emulsification dispersion unit used in the co-emulsification dispersion method may make use of any known units such as a simple stirrer, units in an impeller stirring system or an in-line stirring system, a colloid mill in a mill system, and units in an ultrasonic system, and in the present invention, a high-pressure emulsification dispersion unit is preferable, and in particular a high-pressure homogenizer is particularly preferable.

[0130]

The detailed mechanism of the high-pressure homogenizer is described in US-4533254 and JP-A 6-47264, and as commercial units, a Gaulin homogenizer (trade name, manufactured by A. P. V. Gaulin Inc.), Microfluidizer (trade name, manufactured by Microfluidex Inc.), Altimizer (trade name, manufactured by Sugino Machine Co., Ltd.), etc. can be exemplified.

[0131]

A recent high-pressure homogenizer provided with a mechanism for fine pulverization in an ultrahigh-pressure jet stream as described in US-5720551 is particularly effective for emulsification dispersion in the present invention.

The emulsification dispersion unit using the ultrahigh-pressure

jet stream includes e.g. De BEE 2000 (trade name, manufactured by BEE INTERNATIONAL LTD.).

[0132]

The pressure for emulsification dispersion by means of the ultrahigh-pressure emulsification dispersion unit is preferably 50 MPa or more (500 bar or more), more preferably 60 MPa or more (600 bar or more) and most preferably 180 MPa or more (1800 bar or more).

In the present invention, it is particularly preferable that two or more emulsification units are used in combination in a method wherein the materials are emulsified by a stirring emulsification unit and then passed through a high-pressure homogenizer. Further, it is also preferable that the materials are subjected to emulsification dispersion by these emulsification units, additives such as a wetting agent, a surfactant, etc. are added thereto, and then the ink for ink jet is passed again through the high-pressure homogenizer prior to introduction of the ink into a cartridge.

[0133]

For emulsification dispersion when a low-boiling organic solvent is contained in the hydrophobic high-boiling organic solvent, it is desirable from the viewpoint of the stability, safety and hygiene of the emulsified product that the low-boiling organic solvent is substantially removed.

As the method of substantially removing the low-boiling organic

solvent, various known methods such as an evaporation method, a vacuum evaporation method, an ultrafiltration method, etc. can be used depending on the type of the low-boiling organic solvent. The step of removal of the low-boiling organic solvent is conducted preferably as quickly as possible just after emulsification.

[0134]

In the emulsification dispersion, various surfactants can be used. Preferable examples thereof include anionic surfactants such as fatty acid salts, alkyl sulfates, alkyl benzene sulfonates, alkyl naphthalene sulfonates, dialkyl sulfosuccinates, alkyl phosphates, naphthalene sulfonic acid-formalin condensates and polyoxyethylene alkyl sulfates; nonionic surfactants such as polyoxyethylene alkyl ethers, polyoxyethylene alkyl allyl ethers, polyoxyethylene fatty acid esters, sorbitan fatty acid esters, polyoxyethylene sorbitan fatty acid esters, polyoxyethylene alkyl amines, glycerin fatty acid esters and oxyethylene oxypropylene block copolymers; acetylene type polyoxyethylene oxide surfactant Surfynols (trade name, produced by Air Products & Chemicals Ltd.); amphoteric surfactants such as and amine oxide type surfactants; N,N-dimethyl-N-alkylamine oxide; and those described on pages 37 to 38 in JP-A 59-157,636 and in Research Disclosure No. 308119 (1989).

[0135]

When the colored fine particles containing the oil-soluble dye and the hydrophobic high-boiling organic solvent are dispersed in an aqueous

medium to form an aqueous ink by co-emulsification dispersion, it is particularly important to control the particle size.

To increase color purity and density upon formation of an image by ink jet, the average particle diameter of the colored fine particles in the colored fine particle dispersion is preferably reduced. Specifically, the volume average particle diameter of the colored fine particles is preferably 100 nm or less, more preferably 1 nm to 80 nm.

If there are coarse particles in the colored fine particles, printing performance may be lowered. For example, the coarse particles may clog head nozzles or form stains to prevent ink discharge or to cause uneven discharge, thus adversely affecting printing performance.

Accordingly, the ratio of coarse particles is preferably lower, and for preparation of the ink, it is preferable that the number of 5  $\mu\text{m}$  or more particles is 10 or less and the number of 1  $\mu\text{m}$  or more particles is 1000 or less per  $\mu\text{L}$  of the ink.

As the method of removing these coarse particles, a known centrifugation method, a precision filtration method, etc. can be used. These separation means can be used just after emulsification dispersion or just before charging an ink cartridge with the ink after addition of various additives such as a wetting agent, a surfactant, etc. to the emulsified dispersion. It is effective to use a mechanical emulsification unit in order to reduce the average particle diameter of the colored fine particles and to reduce the coarse particles.



[0136]

The content of the hydrophobic high-boiling organic solvent in the colored fine particle dispersion of the present invention is not particularly limited, but from the viewpoint of the good stainability of the ink on a recording paper, the content of the hydrophobic high-boiling organic solvent in the colored fine particles is preferably 25 % by mass or more.

From the viewpoint of keeping the good solubility of the oil-soluble dye, the hydrophobic high-boiling organic solvent is used in an amount of 30 % by mass or more relative to the oil-soluble dye.

On the other hand, if the amount of the hydrophobic high-boiling organic solvent used is too high, the ratio of the oil phase becomes so high that a stable and fine dispersion is hardly achieved. From this viewpoint, the amount of the hydrophobic high-boiling organic solvent used is preferably 50 to 1500 % by mass, more preferably 100 to 1000 % by mass relative to the oil-soluble dye.

[0137]

- Co-emulsification Dispersion of Water-insoluble Polymer -

For the colored fine particle dispersion of the present invention, a polymer may be added besides the oil-soluble dye and the hydrophobic high-boiling organic solvent at the time of co-emulsification dispersion, to form a colored fine particle dispersion containing the oil-soluble dye, the hydrophobic high-boiling organic solvent and the polymer.

The polymer may be a nonionic polymer or an ionic group-containing polymer.

The ionic group includes cationic groups such as tertiary amino groups and anionic groups such as those from carboxylic acid, sulfonic acid, etc. The ionic group-containing polymer includes e.g. vinyl polymers and condensation polymers (polyurethane, polyester, polyamide, polyurea and polycarbonate).

The method of co-emulsification dispersion of the nonionic polymer or the ionic group-containing polymer with the oil-soluble dye and the hydrophobic high-boiling organic solvent, as well as examples of the polymer, is described in detail in Japanese Patent Application Nos. 2000-203856 and 2000-203857.

In co-emulsification dispersion of the polymer, the dispersion time for achieving a fine particle dispersion tends to be longer with an increasing amount of the polymer added. Accordingly, it is advantageous for achieving a significant effect and improvement in the stability of the colored fine particle dispersion that as shown in the present invention, the water-insoluble polymer fine particles are first prepared and then added to the colored fine particle dispersion substantially not containing the polymer.

[0138]

- Organic Solvent -

The organic solvent other than the hydrophobic high-boiling organic solvent used in production of the colored fine particle dispersion is not particularly limited, and can be selected as necessary depending on the solubility of the oil-soluble dye, and examples thereof include ketone

type solvents such as acetone, methyl ethyl ketone and diethyl ketone, alcohol type solvents such as methanol, ethanol, 2-propanol, 1-propanol, 1-butanol and tert-butanol, chlorine type solvents such as chloroform and methylene chloride, aromatic solvents such as benzene and toluene, ester type solvents such as ethyl acetate, butyl acetate and isopropyl acetate, ether type solvents such as diethyl ether, tetrahydrofuran and dioxane, and glycol ether type solvents such as ethylene glycol monomethyl ether and ethylene glycol dimethyl ether.

These organic solvents may be used singly or in a combination thereof. Depending on the solubility of the oil-soluble dye and the polymer, the solvent may be a mixed solvent with water.

[0139]

The amount of the organic solvent used is not particularly limited insofar as the effect of the present invention is not impaired, but the amount thereof is preferably 2000 parts by mass or less, more preferably 100 to 1000 parts by mass, relative to 100 parts by mass of the oil-soluble dye.

If the amount of the organic solvent used is more than 2000 parts by mass, the cumbersome step of desolvation and concentration for removal of the organic solvent is essential, and allowances in compounding tend to be reduced.

[0140]

If the solubility of the organic solvent in water is 10 % or less or

the vapor pressure of the organic solvent is higher than that of water, the organic solvent is preferably removed for stability of the colored fine particle dispersion.

The organic solvent can be removed at 10 to 100 °C under normal pressure to reduced pressure and preferably at 40 to 100 °C under normal pressure or at 10 to 50 °C under reduced pressure.

[0141]

In the colored fine particle dispersion of the present invention, the colored fine particles are contained in an amount of preferably 1 to 45 % by mass in the ink for ink jet, more preferably 2 to 30 % by mass. Their content can be suitably regulated by dilution, evaporation, ultrafiltration, etc.

[0142]

<Water-Insoluble Ionic Group-Containing Polymer>

The ink for ink jet according to the present invention includes an ionic group-containing water-insoluble polymer added to the colored fine particle dispersion. In this case, it is preferable that the ionic group-containing water-insoluble polymer is converted by emulsification dispersion into a fine particle dispersion and added to the colored fine particle dispersion.

[0143]

Now, the water-insoluble ionic group-containing polymer is

described.

In the present invention, the water-insoluble ionic group-containing polymer refers to a polymer having an ionic group. The ionic group includes cationic groups such as tertiary amino groups and quaternary ammonium groups, and anionic groups in carboxylic acid, sulfonic acid and the like.

The ionic group-containing polymer includes e.g. vinyl polymers and condensation polymers (polyurethane, polyester, polyamide, polyurea and polycarbonate). The water-insoluble ionic group-containing polymer is preferably a water-dispersible (i.e. self-emulsifiable) polymer.

[0144]

The ionic group in the ionic group-containing vinyl polymer includes a carboxyl group, sulfonic acid group, monosulfate group,  $\text{OPO}(\text{OH})_2$ , sulfinic acid group, and salts thereof (e.g., salts of alkali metals such as sodium and potassium), anionic groups such as ammonia, and ammonium salts such as dimethylamine, ethanolamine, diethanolamine, triethanolamine and trimethylamine).

Further, cationic groups such as a primary, secondary, or tertiary amine or salts thereof (e.g., salts of organic acids such as acetic acid, propionic acid, methanesulfonic acid, etc. and salts of inorganic acids such as hydrochloric acid, sulfuric acid, etc.) and quaternary ammonium salts.

Among these, the anionic groups are more preferable, and the carboxyl group is particularly preferable.

[0145]

The carboxylic acid monomer includes e.g. acrylic acid, methacrylic acid, itaconic acid, maleic acid, fumaric acid, citraconic acid, crotonic acid, monoalkyl itaconates (e.g., monomethyl itaconate, monoethyl itaconate, monobutyl itaconate, etc.), and monoalkyl maleates (e.g., monomethyl maleate, monoethyl maleate, monobutyl maleate, etc.).

[0146]

The sulfonic acid monomer includes e.g. styrene sulfonic acid, vinylsulfonic acid, acryloyloxyalkane sulfonic acid (e.g., acryloyloxyethane sulfonic acid, acryloyloxypropane sulfonic acid, etc.), methacryloyloxyalkane sulfonic acid (e.g., methacryloyloxyethane sulfonic acid, methacryloyloxypropane sulfonic acid, etc.), acrylamide alkane sulfonic acid (e.g., 2-acrylamide-2-methylethane sulfonic acid, 2-acrylamide-2-methylpropane sulfonic acid, 2-acrylamide-2-methylbutane sulfonic acid, etc.), and methacrylamide alkane sulfonic acid (e.g., 2-methacrylamide-2-methylethane sulfonic acid, 2-methacrylamide-2-methylpropane sulfonic acid, etc.).

[0147]

The phosphoric acid monomer includes e.g. monoacryloyloxyethyl phosphate, monomethacryloyloxyethyl phosphate, etc.

[0148]

Among these monomers, acrylic acid, methacrylic acid, styrene sulfonic acid, vinyl sulfonic acid, acrylamide alkane sulfonic acid, and methacrylamide alkane sulfonic acid are preferable, among which acrylic acid, methacrylic acid, styrene sulfonic acid, 2-acrylamide-2-methylpropane sulfonic acid and 2-acrylamide-2-methylbutane sulfonic acid are more preferable.

[0149]

The cationic group-containing monomer described above includes e.g. monomers having a tertiary amino group, such as dialkylaminoethyl methacrylate and dialkylaminoethyl acrylate and monomers having a quaternary ammonium group, such as N-2-acryloyloxyethyl-N,N,N-trimethyl ammonium chloride, N-vinylbenzyl-N,N,N-triethyl ammonium chloride, etc.

[0150]

The ionic group-containing monomer may be copolymerized with a monomer having no ionic group, and the monomer having no ionic group includes the following monomers. That is, mention is made of acrylates such as methyl acrylate, ethyl acrylate, n-propyl acrylate, isopropyl acrylate, n-butyl acrylate, isobutyl acrylate, sec-butyl acrylate, tert-butyl acrylate, hexyl acrylate, 2-ethylhexyl acrylate, tert-octyl acrylate, 2-chloroethyl acrylate, 2-bromoethyl acrylate, 4-chlorobutyl acrylate, 2-acetoxyethyl acrylate, benzyl acrylate, cyclohexyl acrylate,

furfuryl acrylate, tetrahydrofurfuryl acrylate, phenyl acrylate, 2-hydroxyethyl acrylate, 2,2-dimethyl-3-hydroxypropyl acrylate, 2-methoxyethyl acrylate, 3-methoxybutyl acrylate, 2-ethoxyethyl acrylate, 2-butoxyethyl acrylate, 2-(2-methoxyethoxy)ethyl acrylate, glycidyl acrylate, 1-bromo-2-methoxyethyl acrylate, 2,2,2-tetrafluoroethyl acrylate, 1H,1H,2H,2H-perfluorodecyl acrylate, diphenyl-2-acryloyloxyethyl phosphate, diphenyl-2-methacryloyloxyethyl phosphate, dibutyl-2-acryloyloxyethyl phosphate, etc.

[0151]

Mention is made of methacrylates such as methyl methacrylate, ethyl methacrylate, n-propyl methacrylate, isopropyl methacrylate, n-butyl methacrylate, isobutyl methacrylate, sec-butyl methacrylate, tert-butyl methacrylate, cyclohexyl methacrylate, benzyl methacrylate, 2-ethylhexyl methacrylate, lauryl methacrylate, stearyl methacrylate, furfuryl methacrylate, tetrahydrofurfuryl methacrylate, phenyl methacrylate, cresyl methacrylate, naphthyl methacrylate, 2-hydroxyethyl methacrylate, 4-hydroxybutyl methacrylate, triethylene glycol monomethacrylate, dipropylene glycol monomethacrylate, 2-methoxyethyl methacrylate, 3-methoxybutyl methacrylate, 2-ethoxyethyl methacrylate, 2-butoxyethyl methacrylate, 2-(2-methoxyethoxy)ethyl methacrylate, 2-(2-ethoxyethoxy)ethyl methacrylate, 2-acetoxyethyl methacrylate, 2-acetoacetoxyethyl methacrylate, allyl methacrylate, glycidyl methacrylate, 2,2,2-tetrafluoroethyl methacrylate, 1H,1H,2H,2H-perfluorodecyl methacrylate, dioctyl-2-



methacryloyloxyethyl phosphate, etc.

[0152]

Mention is made of vinyl esters such as vinyl acetate, vinyl propionate, vinyl butyrate, vinyl caproate, vinyl chloroacetate, vinyl methoxy acetate, vinyl phenyl acetate, vinyl benzoate, vinyl salicylate, etc.

[0153]

Mention is made of acrylamides such as acrylamide, methyl acrylamide, ethyl acrylamide, isopropyl acrylamide, n-butyl acrylamide, tert-butyl acrylamide, tert-octyl acrylamide, cyclohexyl acrylamide, benzyl acrylamide, hydroxymethyl acrylamide, methoxymethyl acrylamide, butoxymethyl acrylamide, methoxyethyl acrylamide, phenyl acrylamide, dimethyl acrylamide, diethyl acrylamide,  $\beta$ -cyanoethyl acrylamide, N-(2-acetoacetoxyethyl) acrylamide, diacetone acrylamide, etc.

[0154]

Mention is made of methacrylamides such as methacrylamide, methyl methacrylamide, ethyl methacrylamide, propyl methacrylamide, n-butyl methacrylamide, tert-butyl methacrylamide, cyclohexyl methacrylamide, benzyl methacrylamide, hydroxymethyl methacrylamide, methoxyethyl methacrylamide, phenyl methacrylamide,  $\beta$ -cyanoethyl methacrylamide, N-(2-acetoacetoxyethyl) methacrylamide,

etc.

[0155]

Mention is made of olefins such as dicyclopentadiene, ethylene, propylene, 1-butene, 1-pentene, vinyl chloride, vinylidene chloride, isoprene, chloroprene, butadiene and 2,3-dimethyl butadiene, as well as styrene and analogues thereof such as methyl styrene, dimethyl styrene, trimethyl styrene, ethyl styrene, chloromethyl styrene, methoxystyrene, actoxystyrene, chlorostyrene, dichlorostyrene, bromostyrene and vinyl methyl benzoate.

[0156]

Mention is made of vinyl ethers such as methyl vinyl ether, butyl vinyl ether, hexyl vinyl ether, and methoxyethyl vinyl ether.

[0157]

Mention is made of other monomers such as butyl crotonate, hexyl crotonate, dimethyl itaconate, dibutyl itaconate, diethyl maleate, dimethyl maleate, dibutyl maleate, diethyl fumarate, dimethyl fumarate, dibutyl fumarate, methyl vinyl ketone, phenyl vinyl ketone, methoxyethyl vinyl ketone, N-vinyl oxazolidone, N-vinyl pyrrolidone, methylene malononitrile, vinylidene, etc.

[0158]

It is also preferable that the ionic group-containing polymer is

copolymerized with a monomer containing a nonionic dispersible group as exemplified below, and the monomer containing a nonionic dispersible group includes e.g. esters of polyethylene glycol monoalkyl ether and carboxylic acid monomer, esters of polyethylene glycol monoalkyl ether and sulfonic acid monomer, esters of polyethylene glycol monoalkyl ether and phosphoric acid monomer, vinyl group-containing urethanes formed from a polyethylene glycol monoalkyl ether and isocyanate group-containing monomer, and macro-monomers having polyvinyl alcohol structures.

The number of repeating ethylene oxy moieties in the polyethylene glycol monoalkyl ether is preferably 8 to 50, more preferably 10 to 30.

The number of carbon atoms in the alkyl group in the polyethylene glycol monoalkyl ether is preferably 1 to 20, more preferably 1 to 12.

[0159]

Now, the ionic group-containing condensation polymer is described.

The polyurethane applicable to the ionic group-containing polymer includes e.g. polyurethanes synthesized by polyaddition reaction of various combinations of the following diol compounds and diisocyanate compounds.

Examples of the diol compounds include non-dissociable diols such as ethylene glycol, 1,2-propanediol, 1,3-propanediol, 1,3-butanediol, 2,3-butanediol, 2,2-dimethyl-1,3-propanediol, 1,4-

pentanediol, 2,4-pentanediol, 3,3-dimethyl-1,2-butanediol, 2-ethyl-2-methyl-1,3-propanediol, 1,6-hexanediol, 2,5-hexanediol, 2-methyl-2,4-pentanediol, 2,2-diethyl-1,3-propanediol, 2,4-dimethyl-2,4-pentanediol, 2-methyl-2-propyl-1,3-propanediol, 2,5-dimethyl-2,5-hexanediol, 2-ethyl-1,3-hexanediol, 1,2-octanediol, 2,2,4-trimethyl-1,3-pentanediol, 1,4-cyclohexane dimethanol, diethylene glycol, triethylene glycol, dipropylene glycol, tripropylene glycol, polyethylene glycol (average molecular weight = 200, 300, 400, 600, 1000, 1500, or 4000), polypropylene glycol (average molecular weight = 200, 400, or 1000), polyester polyol, 4,4'-dihydroxydiphenyl-2,2-propane, 4,4'-dihydroxyphenyl sulfone, etc.

[0160]

Examples of the diisocyanate compounds include ethylene diisocyanate, isophorone diisocyanate, hexamethylene diisocyanate, 1,4-cyclohexane diisocyanate, 2,4-toluene diisocyanate, 1,3-xylylene diisocyanate, 1,5-naphthalene diisocyanate, m-phenylene diisocyanate, p-phenylene diisocyanate, 3,3'-dimethyl-4,4'-diphenyl methane diisocyanate, 3,3'-dimethyl biphenylene diisocyanate, dicyclohexyl methane diisocyanate, methylenebis(4-cyclohexyl isocyanate), etc.

[0161]

The ionic group-containing polyurethane can be obtained by using e.g. an ionic group-containing diol at the time of synthesis of polyurethane. In this case, the ionic group is introduced as a substituent

group from a polymer main chain into polyurethane. Diols containing ionic groups, particularly anionic groups, include, but are not limited to, 2,2-bis(hydroxymethyl) propionic acid, 2,2-bis(hydroxymethyl) butanoic acid, 2,5,6-trimethoxy-3,4-dihydroxyhexanoic acid, 2,3-dihydroxy-4,5-dimethoxypentanoic acid and 3,5-di(2-hydroxy) ethyloxycarbonyl benzene sulfonic acid as well as salts thereof.

[0162]

Ionic groups in the ionic group-containing polyurethane include e.g. anionic groups such as a carboxyl group, sulfonic acid group, monosulfate group,  $-OPO(OH)_2$ , sulfinic acid group, and salts thereof (e.g., salts of alkali metals such as sodium and potassium, ammonia, and ammonium salts such as dimethylamine, ethanolamine, diethanolamine, triethanolamine and trimethylamine) or cationic groups such as primary, secondary and tertiary amines and quaternary ammonium salts, among which the anionic groups are preferable and the carboxyl group is particularly preferable.

[0163]

The polyester applicable to the ionic group-containing polymer includes e.g. polyesters synthesized by condensation reaction of various combinations of the following diol compounds and dicarboxylic acid compounds.

Examples of the dicarboxylic acid compounds include oxalic acid, malonic acid, succinic acid, glutaric acid, dimethyl malonic acid, adipic

acid, pimelic acid,  $\alpha,\alpha$ -dimethyl succinic acid, acetone dicarboxylic acid, sebacic acid, 1,9-nonane dicarboxylic acid, fumaric acid, maleic acid, itaconic acid, citraconic acid, phthalic acid, isophthalic acid, terephthalic acid, 2-butyl terephthalic acid, tetrachloroterephthalic acid, acetylene dicarboxylic acid, poly(ethylene terephthalate) dicarboxylic acid, 1,2-cyclohexane dicarboxylic acid, 1,4-cyclohexane dicarboxylic acid,  $\omega$ -poly(ethylene oxide) dicarboxylic acid, and p-xylylene dicarboxylic acid.

For polycondensation reaction with the diol compound, these compounds may be used in the form of alkyl dicarboxylate (e.g., dimethyl dicarboxylate), dicarboxylic acid chloride, or acid anhydride such as maleic anhydride, succinic anhydride and phthalic anhydride.

[0164]

In addition to carboxylic acids, the ionic group-containing polyester can be synthesized by dicarboxylic acid compounds having ionic groups e.g. anionic groups such as a sulfonic acid group, monosulfate group,  $-\text{OPO}(\text{OH})_2$ , sulfinic acid group, and salts thereof (e.g., salts of alkali metals such as sodium and potassium, ammonia, and ammonium salts such as dimethylamine, ethanolamine, diethanolamine, triethanolamine and trimethylamine) and cationic groups such as tertiary amines or salts thereof (e.g., salts of organic acids such as acetic acid, propionic acid, methanesulfonic acid, etc. and salts of inorganic acids such as hydrochloric acid, sulfuric acid, etc.) and quaternary ammonium salts.

An ionic group other than carboxylic acid in the ionic group-

containing polyester is preferably an anionic group, particularly preferably a sulfonic acid group.

[0165]

Preferable examples of starting materials of the sulfonic acid group-containing dicarboxylic acid and diol include sulfophthalic acids (3-sulfophthalic acid, 4-sulfophthalic acid, 4-sulfoisophthalic acid, 5-sulfoisophthalic acid, 2-sulfoterephthalic acid), sulfosuccinic acid, sulfonaphthalene dicarboxylic acids (4-sulfo-1,8-naphthalene dicarboxylic acid, 7-sulfo-1,5-naphthalene dicarboxylic acid, etc.) and 3,5-di(2-hydroxy) ethyloxycarbonyl benzene sulfonic acid as well as salts thereof.

[0166]

As the diol compound, a compound selected from the diols described above for the polyurethane can be used.

Typical methods of synthesizing the polyester described above include a method of condensation reaction of the diol compound with the dicarboxylic acid or a derivative thereof, a method of condensation of hydroxycarboxylic acids (e.g., 12-hydroxystearic acid), a method of ring-opening polymerization of a cyclic ether with a lactone (detailed in Lecture 6 on Polymerization Reaction, Ring-Opening Polymerization (I) (in Japanese), authored by Takeo Sanshi (Kagaku Dojin, 1971).

[0167]

Polyamides applicable to the ionic group-containing polymer include polyamides synthesized by e.g. polycondensation of various combinations of the following diamine compound and dicarboxylic acid compound, polyamides synthesized by polycondensation of aminocarboxylic acid compounds, and polyamides synthesized by ring-opening polymerization of monomers such as lactams.

[0168]

The diamine compound includes e.g. ethylenediamine, 1,3-propanediamine, 1,2-propanediamine, hexamethylenediamine, octamethylenediamine, o-phenylenediamine, m-phenylenediamine, p-phenylenediamine, piperazine, 2,5-dimethyl piperazine, 4,4'-diaminodiphenyl ether, 3,3'-diaminodiphenyl sulfone, xylylenediamine, etc., and the aminocarboxylic acid compound includes e.g. glycine, alanine, phenylalanine,  $\omega$ -aminohexanoic acid,  $\omega$ -aminodecanoic acid,  $\omega$ -aminoundecanoic acid and anthranilic acid.

The monomer usable in the ring-opening polymerization includes  $\epsilon$ -caprolactam, azetidinone and pyrrolidone.

As the dicarboxylic acid compound, the same dicarboxylic acid compound as described above for the polyester can be used.

[0169]

Polyureas applicable to the ionic group-containing polymer include polyureas synthesized by e.g. polyaddition reaction of various



combinations of the following diamine compound and diisocyanate compound, and polyureas synthesized by ammonia-eliminating reaction of the diamine compound and urea.

As the diamine compound, the same diamine compounds as exemplified above for the polyamide can be used.

As the diisocyanate compound, the same diisocyanate compounds as exemplified above for the polyurethane can be used.

[0170]

Polycarbonates applicable to the ionic group-containing polymer include polycarbonates synthesized by reacting e.g. the following diol compounds with phosgene or a carbonate derivative (e.g., an aromatic ester such as diphenyl carbonate, etc.).

As the diol compound, the same diol compounds as exemplified above for the polyurethane can be used.

[0171]

The ionic group can be introduced by various methods into each of the above polymers. For example, when polyurethane is used, ionic group-containing diol can be used to introduce the ionic group as a substituent group from a polymer main chain at the time of synthesis of polyurethane. When polyester is used, the ionic group can be introduced as an unreacted terminal of the dicarboxylic acid into the terminal of the polymer. Further, after polymerization of each of the above polymers, the ionic group can be introduced by reaction with an acid hydride (e.g.,

maleic anhydride), etc. into a reactive group such as a hydroxy group, amino group, etc.

[0172]

For the ionic group-containing polymer, the vinyl polymer and the condensation polymer, one kind of essential constitutional material may be used for each of them, or depending on various purposes (e.g. regulation of the glass transition temperature (T<sub>g</sub>) of the polymer, solubility thereof, compatibility thereof with dyes, and stability of the dispersion), two or more kinds of constitutional materials may be used in combination in an arbitrary ratio for each of them.

[0173]

The ionic group-containing polymer is preferably a polymer containing a carboxyl group and/or sulfonic acid group as the ionic group, particularly preferably a polymer containing a carboxyl group as the ionic group.

[0174]

The content of the ionic group in the ionic group-containing polymer is preferably 0.1 to 3.0 mmol/g, more preferably 0.2 to 2.0 mmol/g. When the content of the ionic group is too high or too low, the self-emulsifiability of the ionic group-containing polymer is decreased and the stabilizing effect of the oil-soluble dye on the colored fine particle dispersion is reduced.

[0175]

Further, the ionic group may be alkali metals (e.g., sodium, potassium, etc.) or ammonium ion salts as the anionic group described above, or salts of organic acids such as acetic acid, propionic acid, methane sulfonic acid and inorganic acids such as hydrochloric acid, sulfuric acid, etc. as the cationic group (tertiary amine) described above.

[0176]

The ionic group-containing polymer is particularly preferably vinyl polymer, polyurethane or polyester, more preferably vinyl polymer, for impartment of good dispersion stability and easy introduction of the ionic group.

[0177]

Examples (P-1) to (P-54) of the ionic group-containing vinyl polymer are shown below. The ratio in the parentheses means mass ratio. These examples are not intended to limit the present invention.

[0178]

P-1) tert-Butyl methacrylamide-methyl methacrylate-acrylic acid copolymer (60 : 30 : 10)

P-2) n-Butyl acrylate-acrylic acid copolymer (95 : 5)

P-3) Methyl methacrylate-isobutyl methacrylate-acrylic acid copolymer (60 : 30 : 10)

P-4) sec-Butyl acrylate-acrylic acid copolymer (90 : 10)

P-5) Ethyl acrylate-acrylic acid (95 : 5)

P-6) Isopropyl acrylate-acrylic acid copolymer (90 : 10)

P-7) n-Butyl methacrylate-2-hydroxyethyl methacrylate-acrylic acid  
copolymer (85 : 5 : 10)

[0179]

P-8) Isobutyl methacrylate-tetrahydrofurfuryl acrylate-acrylic acid  
copolymer (60 : 30 : 10)

P-9) n-Butyl methacrylate-1H,1H,2H,2H-perfluorodecyl acrylate-acrylic  
acid copolymer (75 : 20 : 5)

P-10) Methyl methacrylate-n-butyl acrylate-acrylic acid copolymer (47.5 :  
47.5 : 5)

P-11) 2-Ethylhexyl methacrylate-methyl acrylate-acrylic acid copolymer  
(40 : 55 : 5)

P-12) 3-Methoxybutyl methacrylate-styrene-acrylic acid copolymer (35 :  
50 : 15)

P-13) Cyclohexyl methacrylate-allyl methacrylate-acrylic acid copolymer  
(70 : 20 : 10)

P-14) Isopropyl methacrylate-2-butoxyethyl methacrylate-acrylic acid  
copolymer (80 : 15 : 5)

P-15) Ethyl acrylate-phenyl methacrylate-acrylic acid copolymer (82 : 15 :  
3)

P-16) Methyl methacrylate-2-ethylhexyl acrylate-acrylic acid copolymer  
(47.5 : 47.5 : 5)

P-17) Isobutyl methacrylate-polyethylene glycol monomethyl ether

(number of repeating ethylene oxy chains: 23) methacrylate-acrylic acid copolymer (70 : 25 : 5)

P-18) Isobutyl methacrylate-dipropylene glycol monomethacrylate-acrylic acid copolymer (85 : 10 : 5)

P-19) Isobutyl methacrylate-polyethylene glycol monomethyl ether (number of repeating ethylene oxy chains: 9) methacrylate-acrylic acid copolymer (85 : 10 : 5)

[0180]

P-20) Isobutyl acrylate-methoxystyrene-acrylic acid copolymer (75 : 15 : 10)

P-21) tert-Butyl acrylate-methacrylic acid copolymer (88 : 12)

P-22) Hexyl acrylate-styrene-methacrylic acid copolymer (80 : 10 : 10)

P-23) 2,2,2-Tetrafluoroethyl methacrylate-methyl methacrylate-methacrylic acid copolymer (35 : 60 : 5)

P-24) Ethyl methacrylate-methacrylic acid copolymer (95 : 5)

P-25) Ethyl methacrylate-2-methoxyethyl methacrylate-methacrylic acid copolymer (70 : 15 : 15)

P-26) n-Butyl methacrylate-methacrylic acid copolymer (95 : 5)

P-27) Vinyl acetate-methacrylic acid copolymer (85 : 15)

P-28) n-Butyl methacrylate-acrylamide-methacrylic acid copolymer (80 : 15 : 5)

P-29) tert-Octyl acrylamide-propyl methacrylate-methacrylic acid copolymer (20 : 65 : 15)

P-30) n-Butyl methacrylate-butoxymethyl acrylamide-methacrylic acid copolymer (80 : 5 : 15)

P-31) n-Butyl methacrylate-diphenyl-2-methacryloyloxyethyl  
phosphate-methacrylic acid copolymer (50 : 40 : 10)

P-32) Isobutyl methacrylate-dimethyl acrylamide-methacrylic acid  
copolymer (80 : 15 : 5)

P-33) n-Butyl methacrylate-phenyl acrylamide-methacrylic acid  
copolymer (70 : 15 : 15)

[0181]

P-34) n-Butyl methacrylate-methoxyethyl methacrylamide-methacrylic  
acid copolymer (70 : 15 : 15)

P-35) Isobutyl methacrylate-2-(2-methoxyethoxy)ethyl methacrylate-  
methacrylic acid copolymer (50 : 35 : 15)

P-36) Ethyl methacrylate-2-carboxyethyl methacrylate copolymer (90 :  
10)

P-37) n-Butyl methacrylate-styrene sulfonic acid copolymer (90 : 10)

P-38) Ethyl methacrylate-styrene sulfonic acid copolymer (90 : 10)

P-39) n-Butyl acrylate-styrene-styrene sulfonic acid copolymer (60 : 35 :  
5)

P-40) n-Butyl acrylate-1H,1H,2H,2H-perfluorodecyl methacrylate-  
styrene sulfonic acid copolymer (80 : 10 : 10)

P-41) n-Butyl methacrylate-2-acrylamide-2-methylethane sulfonic acid  
copolymer (90 : 10)

[0182]

P-42) Isobutyl acrylate-n-butyl methacrylate-2-acrylamide-2-  
methylethane sulfonic acid copolymer (70 : 20 : 10)

P-43) n-Butyl methacrylate-2-acrylamide-2-methylpropane sulfonic acid

copolymer (90 : 10)

P-44) Ethyl methacrylate-2-acrylamide-2-methylpropane sulfonic acid  
copolymer (90 : 10)

P-45) Ethyl acrylate-tert-butyl methacrylate-2-acrylamide-2-  
methylpropane sulfonic acid copolymer (60 : 35 : 5)

P-46) tert-Butyl acrylate-tetrahydrofurfuryl acrylate-2-acrylamide-2-  
methylpropane sulfonic acid copolymer (50 : 40 : 10)

P-47) tert-Butyl acrylate-polyethylene glycol monomethyl ether (number  
of repeating ethylene oxy chains: 23) methacrylate-2-acrylamide-2-  
methylpropane sulfonic acid copolymer (70 : 27 : 3)

P-48) Isobutyl acrylate-N-vinyl pyrrolidone-2-acrylamide-2-  
methylpropane sulfonic acid copolymer (65 : 30 : 5)

P-49) Isobutyl methacrylate-sodium 2-acrylamide-2-methylpropane  
sulfonate copolymer (88 : 12)

[0183]

P-50) n-Butyl methacrylate-2-acrylamide-2-methylpropane sulfonic acid  
copolymer (90 : 10)

P-51) n-Butyl acrylate-tert-butyl methacrylate-vinyl sulfonic acid  
copolymer (60 : 30 : 10)

P-52) Ethyl acrylate-tert-butyl methacrylate-vinyl sulfonic acid  
copolymer (60 : 30 : 10)

P-53) Ethyl methacrylate-2-acrylamide-2-methylbutane sulfonic acid  
copolymer (90 : 10)

P-54) n-Butyl methacrylate-sodium 2-acrylamide-2-methylbutane  
sulfonate copolymer (88 : 12)

[0184]

Examples (P-55) to (P-74) of the condensation polymers among the ionic group-containing polymers described above are shown below, but these examples are not intended to limit the present invention.

Every acidic group in each polymer is shown in a non-dissociated form. Regardless of starting materials, all components in those polymers such as polyester, polyamide, etc. formed by condensation reaction are shown in the form of dicarboxylic acid, diol, diamine, dihydroxycarboxylic acid and aminocarboxylic acid. The ratio in the parentheses shows the molar ratio (%) of each component.

[0185]

P-55) 4,4'-Diphenyl methane diisocyanate/hexamethylene diisocyanate/tetraethylene glycol/ethylene glycol/2,2-bis(hydroxymethyl) propionic acid (40/10/20/20/10)

P-56) 4,4'-Diphenyl methane diisocyanate/hexamethylene diisocyanate/butanediol/polyethylene glycol (Mw = 400)/2,2-bis(hydroxymethyl) propionic acid (40/10/20/10/20)

P-57) 1,5-Naphthylene diisocyanate/butane diol/4,4'-dihydroxy-diphenyl-2,2-propane/polypropylene glycol (Mw = 400)/2,2-bis(hydroxymethyl)propionic acid (50/20/5/10/15)

P-58) 1,5-Naphthylene diisocyanate/hexamethylene diisocyanate/2,5-bis(hydroxymethyl)butanoic acid/polybutylene oxide (Mw = 500) (35/15/25/25)



P-59) Isophorone diisocyanate/diethylene glycol/neopentyl glycol/2,2-bis(hydroxymethyl) propionic acid (50/20/20/10)

P-60) Toluene diisocyanate/2,2-bis(hydroxymethyl) butanoic acid/polyethylene glycol (Mw = 1000)/cyclohexane dimethanol (50/10/10/30)

P-61) Diphenyl methane diisocyanate/hexamethylene diisocyanate/tetraethylene glycol/butanediol/3,5-di(2-hydroxy) ethyloxycarbonylbenzene sulfonic acid (40/10/10/33/7)

P-62) Diphenyl methane diisocyanate/hexamethylene diisocyanate/butanediol/ethylene glycol/2,2-bis(hydroxymethyl) butanoic acid/3,5-di(2-hydroxy) ethyloxycarbonylbenzene sulfonic acid (40/10/20/15/10/5)

[0186]

P-63) Terephthalic acid/isophthalic acid/5-sulfoisophthalic acid/ethylene glycol/neopentyl glycol (24/24/2/25/25)

P-64) Terephthalic acid/isophthalic acid/5-sulfoisophthalic acid/cyclohexane dimethanol/1,4-butanediol/ethylene glycol (22/22/6/25/15/10)

P-65) Isophthalic acid/5-sulfoisophthalic acid/cyclohexane dimethanol/ethylene glycol (40/10/40/10)

P-66) Cyclohexane dicarboxylic acid/isophthalic acid/3,5-di(2-hydroxy) ethyloxycarbonylbenzene sulfonic acid/cyclohexane dimethanol/ethylene glycol (30/20/5/25/20)

[0187]

P-67) 11-Aminoundecanoic acid (100)

P-68) 12-Aminododecanoic acid (100)

P-69) A reaction product of poly(12-aminododecanoic acid) and maleic anhydride

P-70) 11-Aminoundecanoic acid/7-aminoheptanoic acid (50/50)

P-71) Hexamethylene diamine/adipic acid (50/50)

P-72) N,N-dimethyl ethylene diamine/adipic acid/cyclohexane dicarboxylic acid (50/20/30)

[0188]

P-73) Toluene diisocyanate/hexamethylene diamine/2,2-bis(hydroxymethyl) propionic acid (50/40/10)

P-74) 11-Aminoundecanoic acid/hexamethylene diamine/urea (33/33/33)

[0189]

For synthesis of the ionic group-containing condensation polymers described above, it is possible to use known methods described in "Polymer Experiment (Volume 5) Polycondensation and Polyaddition (in Japanese) (edited by Amane Kamihara and published by Kyoritz Shuppan Co., Ltd. (1980)", "Polyester Resin Handbook (in Japanese) (edited by Eiichiro Takiyama and published by The Nikkan Kogyo Shimbum Ltd. (1988))", "Polyurethane Resin Handbook (in Japanese) (edited by Keiji Iwata and published by The Nikkan Kogyo Shimbum Ltd. (1987))", "Experimental Methods in Polymer Synthesis (coauthored by Takayuki Ohzu & Masaetsu Kinoshita and published by Kagaku Dojin (1972))", JP-B 33-1141, JP-B 37-7641, JP-B 39-5989, JP-B 40-27349,

JP-B 42-5118, JP-B 42-24194, JP-B 45-10957, JP-B 48-25435, JP-B 49-36942, JP-B 52-81344, JP-A 56-88454, JP-A 6-340835, etc.

[0190]

The molecular weight ( $M_w$ ) of the ionic group-containing polymer is usually 1,000 to 200,000, preferably 2,000 to 50,000. If the molecular weight is less than 1,000, the stabilizing effect of the colored fine particle dispersion tends to be hardly achieved, while if the molecular weight is greater than 200,000, the addition thereof into the colored fine particle dispersion tends to be difficult owing to difficult formation of an aqueous polymer fine particle dispersion.

[0191]

(Method of Manufacturing Ink for ink jet)

<Addition of Water-insoluble Ionic Group-containing Polymer to Colored Fine Particle Dispersion>

The ink for ink jet according to the present invention is produced by adding the water-insoluble ionic group-containing polymer to the colored fine particle dispersion.

In the present invention, the method of adding the water-insoluble polymer to the colored fine particle dispersion is not particularly limited, and the polymer may be added in a powdery form or as a solution in an organic solvent or as an aqueous dispersion as described above.

It is particularly preferable for the stabilizing effect of the colored

fine particle dispersion that the water-insoluble polymer is formed by emulsification dispersion into a fine particle dispersion, and this fine particle dispersion is mixed with the colored fine particle dispersion.

That is, the method of manufacturing the ink for ink jet according to the present invention preferably features the step of allowing colored fine particles containing at least a hydrophobic high-boiling organic solvent having a boiling point of 150 °C or more and an oil-soluble dye to be dispersed in an aqueous medium to prepare a colored fine particle dispersion and the step of mixing a water-insoluble polymer including an ionic group with the colored fine particle dispersion, and it is particularly preferable in the step of mixing a water-insoluble ionic group-containing polymer with the colored fine particle dispersion that a fine particle dispersion prepared by emulsification dispersion of a water-insoluble ionic group-containing polymer is mixed with the colored fine particle dispersion.

[0192]

The emulsification dispersion method is preferably a method of emulsifying an organic solvent containing the water-insoluble ionic group-containing polymer to form fine particles either by addition of water to said organic solvent solution or by addition of said organic solvent solution to water.

[0193]

The emulsification dispersion unit used in the co-emulsification

dispersion method may make use of any known units such as a simple stirrer, units in an impeller stirring system or an in-line stirring system, a colloid mill in a mill system, and units in an ultrasonic system, and a high-pressure homogenizer is particularly preferably used.

The detailed mechanism of the high-pressure homogenizer is described in US-4533254 and JP-A 6-47264, and as commercial units, a Gaulin homogenizer (trade name, manufactured by A. P. V. Gaulin Inc.), Microfluidizer (trade name, manufactured by Microfluidex Inc.), Altimizer (trade name, manufactured by Sugino Machine Co., Ltd.), etc. can be exemplified.

[0194]

A recent high-pressure homogenizer provided with a mechanism for fine pulverization in an ultrahigh-pressure jet stream as described in US-5720551 is particularly effective for emulsification dispersion in the present invention.

The emulsification dispersion unit using the ultrahigh-pressure jet stream includes e.g. De BEE 2000 (trade name, manufactured by BEE International Ltd.).

[0195]

The pressure for emulsification dispersion by means of the high-pressure emulsification dispersion unit is preferably 50 MPa or more (500 bar or more), more preferably 60 MPa or more (600 bar or more) and most preferably 180 MPa or more (1800 bar or more).

In the present invention, it is particularly preferable that two or more emulsification units are used in combination in a method wherein the materials are emulsified by a stirring emulsification unit and then passed through a high-pressure homogenizer.

[0196]

For emulsification dispersion when a low-boiling organic solvent is contained in the water-insoluble polymer including an ionic group, it is preferable from the viewpoint of the stability, safety and hygiene of the emulsified product that the low-boiling organic solvent is substantially removed.

As the method of substantially removing the low-boiling organic solvent, various known methods such as an evaporation method, a vacuum evaporation method, an ultrafiltration method, etc. can be used depending on the type of the low-boiling organic solvent. The step of removal of the low-boiling organic solvent is conducted preferably as quickly as possible just after emulsification.

[0197]

In the emulsification dispersion, various surfactants can be used. Preferable examples thereof include anionic surfactants such as fatty acid salts, alkyl sulfates, alkyl benzene sulfonates, alkyl naphthalene sulfonates, dialkyl sulfosuccinates, alkyl phosphates, naphthalene sulfonic acid-formalin condensates and polyoxyethylene alkyl sulfates, nonionic surfactants such as polyoxyethylene alkyl ethers,

polyoxyethylene alkyl allyl ethers, polyoxyethylene fatty acid esters, sorbitan fatty acid esters, polyoxyethylene sorbitan fatty acid esters, polyoxyethylene alkyl amines, glycerin fatty acid esters and oxyethylene oxypropylene block copolymers, acetylene type polyoxyethylene oxide surfactants such as Surfynols (trade name, produced by Air Products & Chemicals Ltd.), amphoteric surfactants such as amine oxide type surfactants, N,N-dimethyl-N-alkylamine oxide, and those described on pages 37 to 38 in JP-A 59-157,636 and Research Disclosure No. 308119 (1989).

[0198]

The particle diameter of the water-insoluble ionic group-containing polymer obtained by emulsification dispersion is not particularly limited, but those having a smaller average particle diameter are preferable, and specifically, the volume average particle size is preferably 300 nm or less, more preferably 1 nm to 150 nm.

[0199]

The amount of the water-insoluble ionic group-containing polymer added is not particularly limited, but the polymer is preferably contained in an amount of preferably 0.1 to 30 % by mass, more preferably 1 to 20 % by mass in the ink for ink jet. The content can be suitably regulated depending on the type and amount of the colored fine particle dispersion and other components.

[0200]

<Other Components>

The ink for ink jet according to the present invention comprises the water-insoluble ionic group-containing polymer added to the colored fine particle dispersion of the present invention. Further, the ink for ink jet may comprise other components selected suitably as necessary.

[0201]

The other components may be contained insofar as the effect of the present invention is not impaired, and the other components include known additives such as drying-preventing agents, penetration promoters, UV absorbers, antioxidants, mildew-proofing agents, pH regulators, surface tension regulators, defoaming agents, viscosity regulators, dispersants, dispersion stabilizers, rust preventives, chelating agents, etc.

[0202]

The drying-preventing agent can be suitably used so that an ink jet recording nozzle used in the ink jet recording system is prevented from being clogged owing to drying of the ink for ink jet.

[0203]

The drying preventing agent is preferably a water-soluble organic solvent having a lower vapor pressure than that of water. Examples of the drying preventing agent include polyhydric alcohols, typically ethylene



glycol, propylene glycol, diethylene glycol, polyethylene glycol, thiodiglycol, dithiodiglycol, 2-methyl-1,3-propanediol, 1,2,6-hexanetriol, acetylene glycol derivatives, glycerin and trimethylol propane, lower alkyl ethers of polyhydric alcohols, such as ethylene glycol monomethyl (or ethyl) ethers, diethylene glycol monomethyl (or ethyl) ethers, and triethylene glycol monoethyl (or butyl) ethers, heterocyclic rings such as 2-pyrrolidone, N-methyl-2-pyrrolidone, 1,3-dimethyl-2-imidazolidinone and N-ethyl morpholine, sulfur-containing compounds such as sulforane, dimethyl sulfoxide, and 3-sulforene, multifunctional compounds such as diacetone alcohol and diethanol amine, and urea derivatives.

Among these, polyhydric alcohols such as glycerine and diethylene glycol are preferable. These drying-preventing agents may be used singly or in combination. The content of the drying-preventing agent in the ink for ink jet is preferably 10 to 50 % by mass.

[0204]

The penetration promoters are used preferably for the purpose of sufficiently penetrating the ink for ink jet into paper.

[0205]

The penetration promoters include e.g. alcohols such as ethanol, isopropanol, butanol, di(tri)ethylene glycol monobutyl ether and 1,2-hexanediol, sodium lauryl sulfate, sodium oleate, and nonionic surfactants.

The penetration promoter is contained in such a range that

bleeding of printing, print-through, etc. are not caused, and when contained in an amount of about 5 to 30 % by mass in the ink for ink jet, its sufficient effect is usually demonstrated.

[0206]

The UV absorbers are used for the purpose of improving the storage of images, and include the so-called fluorescent brightening agents, that is, those compounds absorbing ultraviolet rays and emitting fluorescence, typically benzotriazole type compounds described in e.g. JP-A 58-185677, JP-A 61-190537, JP-A 2-782, JP-A 5-197075, JP-A 9-34057, etc., benzophenone type compounds described in JP-A 46-2784, JP-A 5-194483, USP No. 3214463, etc., cinnamic acid type compounds described in JP-B 48-30492, JP-B 56-21141, JP-A 10-88106, etc., triazine type compounds described in JP-A 4-298503, JP-A 8-53427, JP-A 8-239368, JP-A 10-182621, JP-A 8-501291, and stilbene type and benzoxazole type compounds described in Research Disclosure No. 24239.

[0207]

The antioxidants are used for the purpose of improving the storage of images, and for example, various organic and metal complex discoloration-preventing agents can be used.

The organic discoloration-preventing agents include hydroquinones, alkoxyphenols, dialkoxyphenols, phenols, anilines, amines, indanes, chromans, alkoxyanilines, heterocyclic rings, etc.

The metal complex discoloration-preventing agents include nickel complexes, zinc complexes, etc., and specifically, it is possible to use the compounds described in patents cited in Research Disclosure (RD) No. 17643, VII, items I to J, RD No. 15162, RD No. 18716, page 650, left column, RD No. 36544, page 527, RD No. 307105, page 872, and RD No. 15162, as well as the compounds included in the general formulae of typical compounds and in compound examples described in JP-A 62-215272, pages 127 to 137.

[0208]

The mildew-proofing agents include sodium dehydroacetate, sodium benzoate, sodium pyridinethion-1-oxide, ethyl p-hydroxybenzoate, 1,2-benzisothiazoline-3-one and salts thereof. These are used in an amount of preferably 0.02 to 1.00 % by mass in ink.

[0209]

Preferable examples of the surface tension regulators include nonionic, cationic or anionic surfactants.

The surface tension of the ink for ink jet according to the present invention is preferably 25 to 70 mN/m, more preferably 25 to 60 mN/m.

The viscosity of the ink for ink jet according to the present invention is preferably 30 mPa·s or less, more preferably 20 mPa·s or less.

[0210]

As the deforming agents, fluorine or silicone type compounds or

chelating agents represented by EDTA can also be used as necessary.

[0211]

The pH regulators can be used preferably for regulating the pH of the colored fine particle dispersion and conferring dispersion stability, and are added to adjust the ink to preferably pH 4.5 to 10.0, more preferably pH 6 to 10.0.

Preferable examples of the pH regulators include organic bases, inorganic alkalis, etc. as basic ones, and organic acids, inorganic acids, etc. as acidic ones.

Among the basic pH regulators, the organic bases are more preferably triethanolamine, diethanolamine, N-methyl diethanolamine and dimethyl ethanolamine, while the inorganic alkalis are more preferably alkali metal hydroxides, carbonates, ammonia, etc. The alkali metal hydroxides are more preferably sodium hydroxide, lithium hydroxide, potassium hydroxide, etc., the carbonates are more preferably sodium carbonate, sodium hydrogen carbonate, etc.

In the acidic pH regulators, the organic acids are more preferably acetic acid, propionic acid, trifluoroacetic acid and alkyl sulfonic acid, while the inorganic acids are more preferably hydrochloric acid, sulfuric acid, phosphoric acid, etc.

[0212]

(Ink Jet Recording Method)

In the ink jet recording method of the present invention, the ink

for ink jet is used for recording on an image-receiving material, but ink nozzles, etc. used are not particularly limited and can be selected depending on the object.

[0213]

<Image-Receiving Material>

The recording material is not particularly limited, and may be a known recording material such as paper, resin-coated paper, paper for exclusive use in ink jet recording, film, electrophotographic paper, woven goods, glass, metal, ceramic ware, etc.

The recording material is preferably paper for exclusive use in ink jet recording, and more preferable examples thereof are those described in e.g. JP-A 8-169172, JP-A 8-27693, JP-A 2-276670, JP-A 7-276789, JP-A 9-323475, JP-A 62-238783, JP-A 10-153989, JP-A 10-217473, JP-A 10-235995, JP-A 10-337947, JP-A 10-217597, JP-A 10-337947, etc.

[0214]

Among the image-recording materials described above, the following recording paper and recording film are particularly preferable in the present invention.

[0215]

The recording paper and recording film comprise a support and an ink-receiving layer laminated thereon, and as necessary, other layers

such as a back coat, etc. may be laminated thereon.

Each layer, such as the ink-receiving layer, may consist of one layer or two or more layers.

[0216]

The support includes chemical pulp such as LBKP and NBKP, machine pulp such as GP, PGW, RMP, TMP, CTMP, CMP, CGP, etc., and waste pulp such as DIP, etc. The pulp may contain known dyes, binders, sizing agents, fixing agents, cationic agents, and paper force enhancers as necessary. The support produced by various apparatuses such as wire paper machines can be used, or the support may be synthetic paper, plastic film sheet, etc.

[0217]

The thickness of the support is about 10 to 250  $\mu\text{m}$ , and the basis weight thereof is desirably 10 to 250  $\text{g}/\text{m}^2$ .

[0218]

The support may be provided with the ink-receiving layer and further with the back coat layer, or the support may be provided first with a size press layer or an anchor coat layer of starch, polyvinyl alcohol, etc. thereon and then provided with the ink-receiving layer and the back coat layer.

The support may be flattened by calendering machines such as machine calendering, TG calendering and soft calendering machines.

[0219]

The support used is preferably a paper or a plastic film having polyolefins (e.g., polyethylene, polystyrene, polyethylene terephthalate, polybutene and copolymers thereof) laminated on both sides thereof.

It is more preferable to add white dyes (e.g., titanium oxide, zinc oxide) or coloring dyes (e.g., cobalt blue, ultramarine blue, neodymium oxide) to said polyolefins.

[0220]

The ink-receiving layer contains a pigment, an aqueous binder, a mordant, a water-resistance-conferring agent, a light-resistance improver, a surfactant and other additives.

[0221]

The pigment is preferably a white pigment. The white pigment includes e.g. inorganic white pigments such as calcium carbonate, kaolin, talc, clay, diatomaceous earth, synthetic amorphous silica, aluminum silicate, magnesium silicate, calcium silicate, aluminum hydroxide, alumina, lithopone, zeolite, barium sulfate, calcium sulfate, titanium dioxide, zinc sulfide, and zinc carbonate, as well as organic pigments such as styrene type pigments, acrylic pigments, urea resin, and melamine resin.

These white pigments are preferably porous inorganic pigments, particularly preferably synthetic amorphous silica, etc. with pores of

large area.

The synthetic amorphous silica may be silicic anhydride obtained in a dry process or hydrous silicic acid obtained in a wet process, among which hydrous silicic acid is used particularly preferably.

[0222]

The aqueous binder includes e.g. water-soluble polymers such as polyvinyl alcohol, silanol-modified polyvinyl alcohol, starch, cationic starch, casein, gelatin, carboxymethyl cellulose, hydroxyethyl cellulose, polyvinyl pyrrolidone, polyalkylene oxide and polyalkylene oxide derivatives, as well as water-dispersible polymers such as styrene butadiene latex, acryl emulsion, etc.

These aqueous binders may be used singly or in combination. Among these binders, polyvinyl alcohol and silanol-modified polyvinyl alcohol are preferable for adhesion to the pigment and difficult removal of the ink-receiving layer.

[0223]

The mordant is preferably in a passive state. Accordingly, a polymer mordant is preferably used.

Preferable examples of the polymer mordant includes polymer mordants described in JP-A 48-28325, JP-A 54-74430, JP-A 54-124726, JP-A 55-22766, JP-A 55-142339, JP-A 60-23850, JP-A 60-23851, JP-A 60-23852, JP-A 60-23853, JP-A 60-57836, JP-A 60-60643, JP-A 60-118834, JP-A 60-122940, JP-A 60-122941, JP-A 60-122942, JP-A 60-



235134, JP-A 1-161236, US-P 2484430, US-P 2548564, US-P 3148061, US-P 3309690, US-P 4115124, US-P 4124386, US-P 4193800, US-P 4273853, US-P 4282305, and US-P 4450224. The polymer mordants described on pp. 212 to 215 in JP-A 1-161236 are particularly preferable. The polymer mordants described therein can be used for endowing images with excellent qualities and for improving light resistance of images.

[0224]

The water resistance-conferring agent is effective for making images water-resistant, and preferable examples thereof include cationic resin.

The cationic resin includes e.g. polyamide polyamine epichlorohydrin, polyethylene imine, polyamine sulfone, a polymeric product of dimethyl diallyl ammonium chloride, cation polyacrylamide, etc. Among these cationic resins, polyamide polyamine epichlorohydrin is particularly preferable.

The content of the cationic resin is preferably 1 to 15 % by mass, more preferably 3 to 10 % by mass, relative to the total solid content of the ink-receiving layer.

[0225]

The light-resistance improver includes e.g. zinc sulfate, zinc oxide, hindered amine antioxidants, benzotriazole UV absorbers and benzophenone UV absorbers, etc. Among these, zinc sulfate is

particularly preferable.

[0226]

The surfactant described above functions as a coating aid, a releasability improver, a sliding improver or an antistatic agent. The surfactant includes those described in JP-A 62-173463 and JP-A 62-183457.

An organic fluoro compound may be used in place of the surfactant. The organic fluoro compound is preferably hydrophobic. The organic fluoro compound includes e.g. fluorine type surfactants, oily fluorine type compounds (e.g., fluorine oil) and solid fluorine compound resins (e.g., ethylene tetrafluoride resin).

The organic fluoro compounds are described in JP-B 57-9053 (columns 8 to 17), JP-A 61-20994 and JP-A 62-135826.

[0227]

The other additives include e.g. a pigment dispersant, a thickening agent, a defoaming agent, a dye, a fluorescent brightening agent, a preservative, a pH regulator, a matting agent, a hardener, etc.

[0228]

The back coat layer described above contains a white pigment, an aqueous binder and other components.

[0229]

The white pigment includes e.g. white inorganic pigments such as light calcium carbonate, heavy calcium carbonate, kaolin, talc, calcium sulfate, barium sulfate, titanium dioxide, zinc oxide, zinc sulfide, zinc carbonate, satin white, aluminum silicate, diatomaceous earth, calcium silicate, magnesium silicate, synthetic amorphous silica, colloidal silica, colloidal alumina, pseudo-boehmite, aluminum hydroxide, alumina, lithopone, zeolite, hydrated halloysite, magnesium carbonate and magnesium hydroxide, as well as organic pigments such as styrene type plastic pigment, acrylic plastic pigment, polyethylene, microcapsules, urea resin, melamine resin, etc.

[0230]

The aqueous binder includes water-soluble polymers such as styrene/maleate copolymer, styrene/acrylate copolymer, polyvinyl alcohol, silanol-modified polyvinyl alcohol, starch, cationic starch, casein, gelatin, carboxymethyl cellulose, hydroethyl cellulose and polyvinyl pyrrolidone, as well as water-dispersible polymers such as styrene butadiene latex, acryl emulsion, etc.

[0231]

The other components include a defoaming agent, a foam inhibitor, a dye, a fluorescent brightening agent, a preservative, a water resistance-conferring agent, etc.

[0232]

A polymer latex may be added to each constitutional layer (including the back coat layer) in the recording paper and recording film described above.

The polymer latex is used for the purpose of improving physical properties such as improvement of dimensional stability of film and prevention of film curling, adhesion and cracking.

The polymer latex is described in JP-A 62-245258, JP-A 62-136648 and JP-A 62-110066.

If the polymer latex having a low glass transition temperature (40 °C or less) is added to a layer containing the mordant, the cracking and curling of the layer can be prevented. Further, if the polymer latex having a high glass transition temperature is added to the back coat layer, curling can be prevented.

[0233]

The image-receiving material used in the ink jet recording method of the present invention is not particularly limited, but a recording material comprising an ink-receiving layer containing a white pigment laminated on a support is preferably used to produce high-quality images.

Further, when a large number of conventional dispersion inks are used on a recording material comprising an ink receiving layer containing a porous inorganic pigment such as white pigment, their ability to penetrate the recording material is poor, so there is the problem that

when the formed image is rubbed with hands, the dye is removed from the surface. However, the ink of the present invention is superior in the ability to penetrate the recording material, thus solving this problem. Accordingly, the recording material can be used to produce high-quality and high-strength images.

[0234]

The ink jet recording system of the present invention is not particularly limited and may be any known method such as a charge regulating system utilizing electrostatically induced force to discharge ink, a drop-on-demand system (pressure pulse system) utilizing a vibration pressure of piezo elements, an acoustic ink jet system of converting an electric signal into an acoustic beam which is irradiated on ink to discharge the ink by the radiation pressure, and a thermal ink jet (bubble jet) system of heating ink to form bubbles and utilizing the resulting pressure, etc.

The ink jet recording systems described above include a system of jetting an ink of low concentration (called photo ink) in a large number of small volumes, a system of improving the qualities of images by use of a plurality of inks having substantially the same hue but different concentrations, and a system of using a colorless transparent ink.

[0235]

[Examples]

Hereinafter, Examples of the present invention are described, but

these Examples are not intended to limit the present invention.

[0236]

(Example 1)

<Preparation of Water-insoluble Ionic Group-containing Polymer Fine Particle Dispersion>

- Preparation of Ionic Group-containing Polymer Fine Particle Dispersion PD-1 -

3.0 g of the water-insoluble ionic group-containing polymer (P-10) was dissolved in 17 g of isopropyl alcohol in a 200 ml three-necked flask equipped with a stirrer and a reflux condenser, and 0.17 g of sodium hydrogen carbonate and 1 g of distilled water were added thereto and heated at 80 °C under stirring.

50 ml of distilled water was added dropwise to this mixture at a rate of 1 ml/min. under stirring. Thereafter, the resulting ionic group-containing polymer fine particle dispersion was concentrated at 40 °C under reduced pressure and filtered through a filter cloth of 225 mesh size to give an ionic group-containing polymer fine particle dispersion (PD-1) with a solid content of 18.0 %.

The particle diameter of the ionic group-containing polymer fine particle dispersion was 28.2 nm.

[0237]

- Preparation of Ionic Group-containing Polymer Fine Particle

Dispersions (PD-2) to (PD-9) -

The ionic group-containing polymer fine particle dispersions (PD-2) to (PD-9) were prepared in the same manner as in production of PD-1 described above except that the type of the ionic group-containing polymer was changed as shown in Table 1.

[0238]

[Table 1]

Table 1: Preparation of  
water-insoluble ionic group-containing polymer fine particle dispersions

Polymer fine particle dispersion	Ionic group- containing polymer	Solid content (%)	Particle diameter (nm)
PD-1	P-10	18.0	28
PD-2	P-16	17.7	19
PD-3	P-44	19.3	11
PD-4	P-36	21.3	14
PD-5	P-24	17.1	18
PD-6	P-26	19.4	15
PD-7	P-2	10.5	16
PD-8	P-55	16.5	33
PD-9	P-63	17.8	24

[0239]

<Preparation of Comparative Ink for ink jet 101>

2.5 g of an oil-soluble dye (M-6), 1.6 g of sodium dioctyl sulfosuccinate, 1.8 g of a hydrophobic high-boiling organic solvent (S-2) and 3.2 g of a hydrophobic high-boiling organic solvent (S-11) were dissolved in 75 ml of ethyl acetate at 75 °C. 75 ml of deionized water

heated to 75 °C was poured into this solution and then emulsified at 10,000 rpm for 4 minutes with a homogenizer, and this emulsification was repeated 6 times in total at 1 minute intervals.

Then, the resulting emulsion was concentrated in a nitrogen flow until an odor of ethyl acetate disappeared, and the concentrate was then filtered to give a colored fine particle dispersion.

Further, diethylene glycol, glycerin and deionized water were added to the resulting colored fine particle dispersion, such that a magenta ink for ink jet (comparative ink for ink jet 101), comprising 2 % by mass of oil-soluble dye, 5 % by mass of diethylene glycol and 5 % by mass of glycerin in 100 ml of the final solution, was obtained.

The volume average particle diameter of the colored fine particles in the resulting ink for ink jet, as determined by a Micro-track UPA<sup>TM</sup> (Nikkiso Co., Ltd.), was 83 nm.

[0240]

<Preparation of Inks for Ink Jet Recording 102 to 110>

Magenta inks for ink jet recording (inks for ink jet recording 102 to 110), comprising 2 % by mass of oil-soluble dye, 2 % by mass of ionic group-containing polymer fine particle dispersion, 5 % by mass of diethylene glycol and 5 % by mass of glycerin, were prepared in the same manner as in the process for preparing comparative ink for ink jet 101 as described above, except that the water-insoluble ionic group-containing polymer fine particle dispersion shown in Table 2 was added to the colored fine particle dispersion after the concentration step was



completed.

[0241]

<Preparation of Comparative Ink for ink jet 111>

A magenta ink for ink jet (comparative ink for ink jet 111) comprising 2 % by mass of oil-soluble dye, 2 % by mass of ionic group-containing polymer fine particle dispersion, 5 % by mass of diethylene glycol and 5 % by mass of glycerin was prepared in the same manner as in the process for preparing comparative ink for ink jet 101 as described above, except that 2.5 g of the oil-soluble dye (M-6), 1.6 g of sodium dioctyl sulfosuccinate, 1.8 g of the hydrophobic high-boiling organic solvent (S-2), 3.2 g of the hydrophobic high-boiling organic solvent (S-11) and 2.5 g of the water-insoluble ionic group-containing polymer (P-10) were dissolved in the 75 ml of ethyl acetate at 75 °C.

The volume average particle diameter of the colored fine particles in the resulting ink for ink jet, as determined by a Micro-track UPA<sup>TM</sup> (Nikkiso Co., Ltd.), was 110 nm.

[0242]

[Table 2]

Table 2: Preparation of inks for ink jet recording  
and changes of particle diameters with time

Ink for ink jet	Ionic group- containing polymer fine particle dispersion	Volume average particle diameter (nm)		
		Day 0	Day 10	
101	--	83	95	Comparative Example
102	PD-1	79	81	Present Invention
103	PD-2	79	74	Present Invention
104	PD-3	78	84	Present Invention
105	PD-4	79	79	Present Invention
106	PD-5	85	79	Present Invention
107	PD-6	71	74	Present Invention
108	PD-7	81	80	Present Invention
109	PD-8	82	83	Present Invention
110	PD-9	83	83	Present Invention
111	--	110	112	Comparative Example

[0243]

<Stability of Inks for Ink Jet Recording 101 to 111 with Time>

After the prepared inks 101 to 111 for ink jet recording had been left for 10 days at 80 °C, the volume average particle diameters of the colored fine particles were measured. The results are shown in Table 2. From the results in Table 2, it is clear that the stability of the ink for ink jet with time was significantly improved by adding the water-insoluble ionic group-containing polymer of the present invention.

Further, it is clear that even in the case where the water-insoluble ionic group-containing polymer was added in the same formulation, an

ink of the present invention prepared by mixing the water-insoluble ionic group-containing polymer fine particle dispersion with the colored fine particle dispersion substantially not containing the polymer, as compared with an ink prepared by co-emulsification dispersion thereof, has a smaller volume average particle diameter and is thus more advantageous to the progress of dispersion.

[0244]

(Example 2)

<Preparation of Comparative Ink Set 201>

8 g of the oil-soluble dye (M-6) and 5 g of sodium dioctyl sulfosuccinate were dissolved in 6 g of the hydrophobic high-boiling organic solvent (S-2), 10 g of the hydrophobic high-boiling organic solvent (S-11), 5.0 g of UV absorbers UV1 to UV5 (a mixture in the ratio 1 : 2 : 2 : 3 : 1 by weight) and 50 ml ethyl acetate at 70 °C. 500 ml deionized water was added to this solution under stirring with a magnetic stirrer to prepare a coarse particle dispersion of oil-in-water type.

Next, this coarse particle dispersion was passed 5 times through a Microfluidizer<sup>TM</sup> (Microfluidex Inc.) at a pressure of 60 MPa (600 bar) to form fine particles. The solvent was removed from the resulting emulsion in a rotary evaporator until an odor of ethyl acetate disappeared, and a colored fine particle dispersion was obtained.

[0245]

160 g of diethylene glycol, 64 g of glycerin, 7 g of Surfynol 465<sup>TM</sup>

(Air Products & Chemicals) and additives such as urea were added to the resulting colored fine particle dispersion, and deionized water was added thereto, and the dispersion was adjusted to pH 9 with 10 mol/l KOH, to prepare a light magenta ink for ink jet. The composition of the resulting light magenta ink is shown in Table 3 below.

The volume average particle diameter of the colored fine particles in the resulting ink for ink jet, as determined by a Micro-track UPA<sup>TM</sup> (Nikkiso Co., Ltd.), was 47 nm.

[0246]

Further, a comparative ink set 201 (including a magenta ink, a light cyan ink, a cyan ink, a yellow ink and a black ink) as shown in Table 14 was prepared by changing the type of the oil-soluble dye and hydrophobic high-boiling organic solvent used.

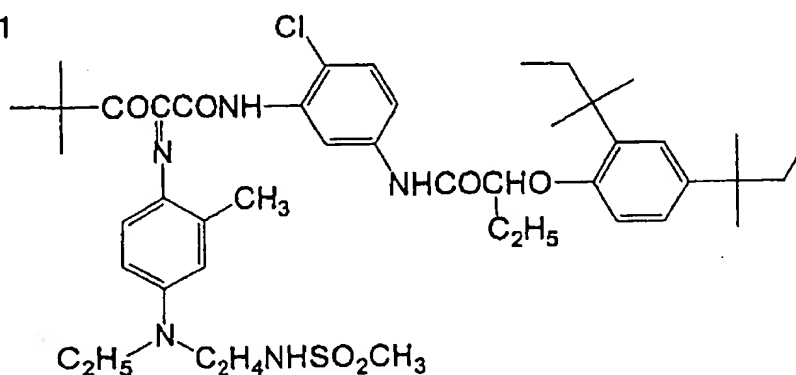
[Table 3]

Table 3: Comparative ink set 201

	Light magenta	Magenta	Light cyan	Cyan	Yellow	Black
Dye (g/l)	M-6 5.00	M-6 20.0	C-1 9.3	C-1 37.2	Y-1 27.2	M-6 10.0 C-1 18.6 Y-1 13.6
High-boiling S-1 organic solvent S-2 (g/l)	3.8 6.3	15.0 25.0	7.0 11.8	27.9 47.0	20.4 34.0	31.7 53.3
UV absorber (g/l) (1 / 2 / 2 / 3 / 1 mixture of UV1/UV2/UV3/UV4/UV5)	3.13	12.5	5.8	23.3	17.0	26.4
Sodium dioctyl sulfosuccinate (g/l)	3.13	12.5	5.8	23.3	17.0	26.4
Diethylene glycol (g/l)	100.0	100.0	100.0	100.0	100.0	100.0
Urea (g/l)	46.0	46.0	46.0	46.0	46.0	46.0
Glycerin (g/l)	40.0	40.0	40.0	40.0	40.0	40.0
SURFYNOL 465 (g/l)	5.5	5.5	5.5	5.5	5.5	5.5
Triethanolamine (g/l)	7.5	7.5	7.5	7.5	7.5	7.5
Benzotriazole (g/l)	0.075	0.075	0.075	0.075	0.075	0.075
Proxel XL2(g/l)	2.5	2.5	2.5	2.5	2.5	2.5
Adjusted to 1 L with deionized water						
Volume average particle diameter (nm)	47	53	56	57	49	64

[0248]

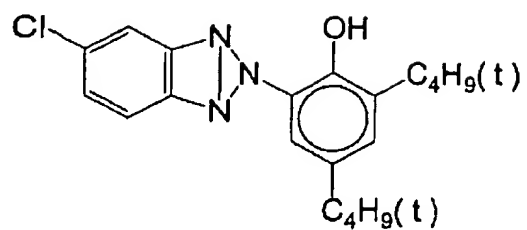
[Formula 35]  $\gamma - 1$



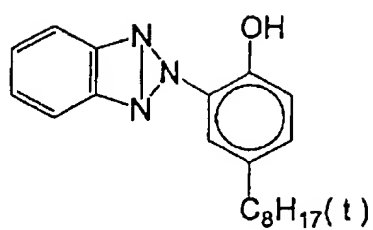
[0249]

[Formula 36]

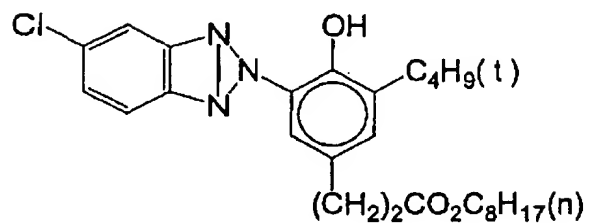
U V 1



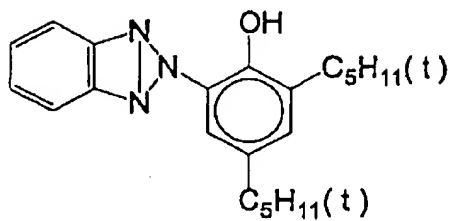
U V 2



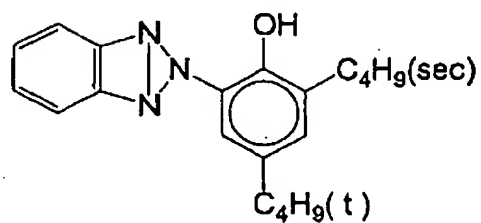
U V 3



U V 4



U V 5



A mixture of (1), (2), (3), (4) and (5)  
mixed in the ratio of 1 : 2 : 2 : 3 : 1 (by mass)

[0250]

<Preparation of Ink Sets 202 to 206>

Ink sets 202 to 206 according to the present invention were prepared in the same manner as in the process for preparing the comparative ink set 201 as described above, except that after deionized water was added, the water-insoluble ionic group-containing polymer fine particle dispersion of the present invention shown in Table 4 was added. (The total liquid volume of deionized water and the water-insoluble ionic group-containing polymer dispersion of the present invention was made constant. The mass of each ionic group-containing polymer fine particle dispersion shown in Tables 4-1 to 4-2 indicates the solid content of the polymer per liter of the ink.)

[0251]

<Preparation of Ink Sets 207 to 215>

Then, comparative ink sets 207 and 211 were prepared in the same manner as for the comparative ink set 201 described above except that the type and amount of the oil-soluble dye and high-boiling organic solvent were changed as shown in Tables 4-1 to 4-2.

Further, ink sets 208 to 210 of the present invention corresponding to the comparative ink set 207, and ink sets 212 to 214 of the present invention corresponding to the comparative ink set 211, were prepared respectively in the same manner as for the ink sets 202 to 206 described above except that each water-insoluble ionic group-containing polymer fine particle dispersion of the present invention shown in Tables

4-1 to 4-2 was added.

Further, ink set 215 shown in Table 5 was prepared as a comparative ink set using a water-soluble dye.

[0252]

[Table 4]

Table 4-1: Ink sets 201 to 207

Ink Set		Light magenta	Magenta	Light cyan	Cyan	Yellow	Black	Remarks
201	Dye (g/l)	M-6 5.0	M-6 20.0	C-1 9.3	C-1 37.2	Y-1 27.2	M-6 10.0 C-1 18.6 Y-1 13.6	Compa- rative Example
	High-boiling organic solvent S-2/ S-11	3.8 6.3	15.0 25.0	7.0 11.8	27.9 47.0	20.4 34.0	31.7 53.3	
	Volume particle diameter (nm)	47	53	56	57	49	64	
202	Dye (g/l)	M-6 5.0	M-6 20.0	C-1 9.3	C-1 37.2	Y-1 27.2	M-6 10.0 C-1 18.6 Y-1 13.6	Present Invention
	High-boiling organic solvent S-2/ S-11	3.8 6.3	15.0 25.0	7.0 11.8	27.9 47.0	20.4 34.0	31.7 53.3	
	Volume particle diameter (nm)	47	53	56	57	49	64	
	Ionic group-containing polymer fine particle dispersion PD-1 (g/l)	50	25	50	25	25	25	
203	Dye (g/l)	M-6 5.0	M-6 20.0	C-1 9.3	C-1 37.2	Y-1 27.2	M-6 10.0 C-1 18.6 Y-1 13.6	Present Invention
	High-boiling organic solvent S-2/ S-11	3.8 6.3	15.0 25.0	7.0 11.8	27.9 47.0	20.4 34.0	31.7 53.3	
	Volume particle diameter (nm)	47	53	56	57	49	64	
	Ionic group-containing polymer fine particle dispersion PD-3 (g/l)	50	25	50	25	25	25	
204	Dye (g/l)	M-6 5.0	M-6 20.0	C-1 9.3	C-1 37.2	Y-1 27.2	M-6 10.0 C-1 18.6 Y-1 13.6	Present Invention
	High-boiling organic solvent S-10/ S-15	7.5 2.5	30.0 10.0	7.0 11.8	18.8 56.4	13.6 40.8	21.3 63.8	
	Volume particle diameter (nm)	48	51	49	56	45	60	
	Ionic group-containing polymer fine particle dispersion PD-1 (g/l)	50	25	50	25	25	25	



205	Dye (g/l)	M-6 5.0	M-6 20.0	C-1 9.3	C-1 37.2	Y-1 27.2	M-6 10.0 C-1 18.6 Y-1 13.6	Present Invention
	High-boiling S-10/ organic solvent S-15	7.5	30.0	7.0	18.8	13.6	21.3	
	Volume particle diameter (nm)	48	51	49	56	45	60	
	Ionic group-containing polymer fine particle dispersion PD-8 (g/l)	50	25	50	25	25	25	
206	Dye (g/l)	M-6 5.0	M-6 20.0	C-1 9.3	C-1 37.2	Y-1 27.2	M-6 10.0 C-1 18.6 Y-1 13.6	Present Invention
	High-boiling S-2/ organic solvent S-11	3.8	15.0	7.0	27.9	20.4	31.7	
	Volume particle diameter (nm)	47	53	56	57	49	64	
	Ionic group-containing polymer fine particle dispersion PD-3 (g/l)	20	10	20	10	10	10	
	Polymer latex SBR (g/l) (Note 1)	30	15	30	15	15	15	
207	Dye (g/l)	MM-2 3.6	MM-2 14.4	CC-2 17.4	CC-2 69.6	YY-2 26.5	MM-2 6.5 CC-2 34.8 YY-2 13.3	Compa- rative Example
	High-boiling S-2/ organic solvent S-11	2.6	10.5	12.6	50.5	19.2	39.6	
	Volume particle diameter (nm)	43	48	53	56	47	61	

[0253]

[Table 5]

Table 4-2: Ink sets 208 to 214

Ink Set		Light magenta	Magenta	Light cyan	Cyan	Yellow	Black	Remarks
208	Dye (g/l)	MM-2 3.6	MM-2 14.4	CC-2 17.4	CC-2 69.6	YY-2 26.5	MM-2 6.5 CC-2 34.8 YY-2 13.3	Present Invention
	High-boiling S-2/ organic solvent S-11	2.6	10.5	12.6	50.5	19.2	39.6	
	Volume particle diameter (nm)	43	48	53	56	47	61	
	Ionic group-containing polymer fine particle dispersion PD-2 (g/l)	50	25	50	25	25	25	
209	Dye (g/l)	MM-2 3.6	MM-2 14.4	CC-2 17.4	CC-2 69.6	YY-2 26.5	MM-2 6.5 CC-2 34.8 YY-2 13.3	Present Invention
	High-boiling S-2/ organic solvent S-11	2.6	10.5	12.6	50.5	19.2	39.6	
		4.6	18.5	22.1	88.7	33.7	69.6	

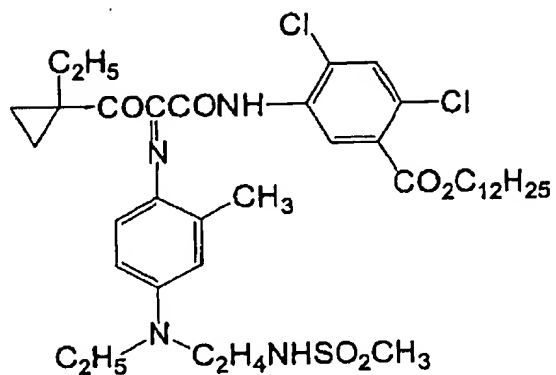
	Volume particle diameter (nm)	43	48	53	56	47	61	
	Ionic group-containing polymer fine particle dispersion PD-4 (g/l)	50	25	50	25	25	25	
210	Dye (g/l)	MM-2 3.6	MM-2 14.4	CC-2 17.4	CC-2 69.6	YY-2 26.5	MM-2 6.5 CC-2 34.8 YY-2 13.3	Present Invention
	High-boiling organic solvent S-2/ S-11	2.6 4.6	10.5 18.5	12.6 22.1	50.5 88.7	19.2 33.7	39.6 69.6	
	Volume particle diameter (nm)	43	48	53	56	47	61	
	Ionic group-containing polymer fine particle dispersion PD-9 (g/l)	50	25	50	25	25	25	
211	Dye (g/l)	MM-3 3.6	MM-3 14.4	CC-3 17.4	CC-3 69.6	YY-2 26.5	MM-3 6.5 CC-3 34.8 YY-2 13.3	Comparative Example
	High-boiling organic solvent S-9/ S-24	2.9 4.3	11.5 17.3	13.9 20.9	55.7 83.5	21.2 31.8	43.6 65.5	
	Volume particle diameter (nm)	42	45	50	58	47	62	
212	Dye (g/l)	MM-3 3.6	MM-3 14.4	CC-3 17.4	CC-3 69.6	YY-2 26.5	MM-3 6.5 CC-3 34.8 YY-2 13.3	Present Invention
	High-boiling organic solvent S-9/ S-24	2.9 4.3	11.5 17.3	13.9 20.9	55.7 83.5	21.2 31.8	43.6 65.5	
	Volume particle diameter (nm)	42	45	50	58	47	62	
	Ionic group-containing polymer fine particle dispersion PD-5 (g/l)	30	15	30	15	15	15	
213	Dye (g/l)	MM-3 3.6	MM-3 14.4	CC-3 17.4	CC-3 69.6	YY-2 26.5	MM-3 6.5 CC-3 34.8 YY-2 13.3	Present Invention
	High-boiling organic solvent S-9/ S-24	2.9 4.3	11.5 17.3	13.9 20.9	55.7 83.5	21.2 31.8	43.6 65.5	
	Volume particle diameter (nm)	42	45	50	58	47	62	
	Ionic group-containing polymer PD-1/ fine particle PD-6	30 20	15 10	30 20	15 10	15 10	15 10	
214	Dye (g/l)	MM-3 3.6	MM-3 14.4	CC-3 17.4	CC-3 69.6	YY-2 26.5	MM-3 6.5 CC-3 34.8 YY-2 13.3	Present Invention
	High-boiling organic solvent S-9/ S-24	2.9 4.3	11.5 17.3	13.9 20.9	55.7 83.5	21.2 31.8	43.6 65.5	
	Volume particle diameter (nm)	42	45	50	58	47	62	
	Ionic group-containing polymer fine particle dispersion PD-2 (g/l)	80	40	80	40	40	40	

Note 1: An SBR-styrene/butadiene (ratio by mass: 37/63) latex (emulsion polymer)

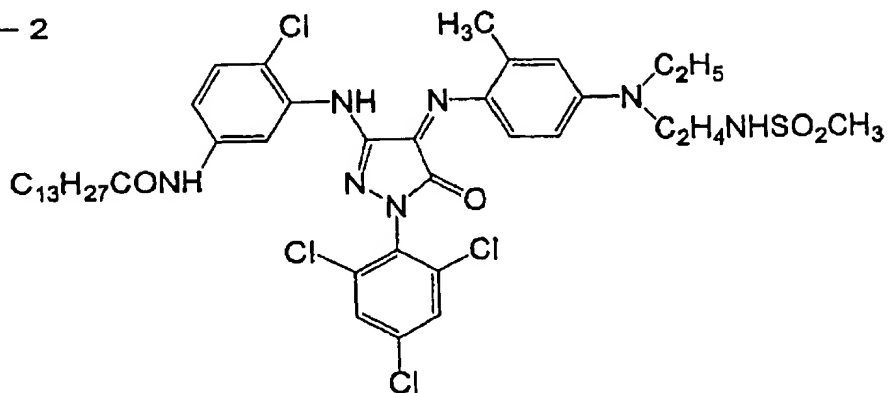
[0254]

[Formula 37]

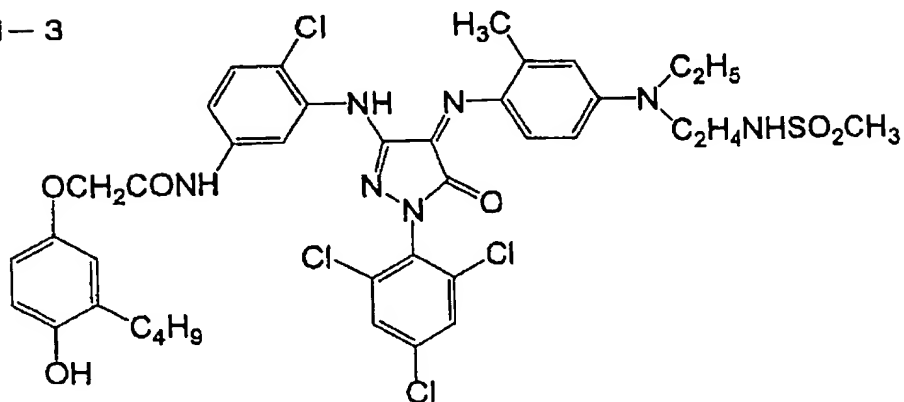
YY-2



MM-2



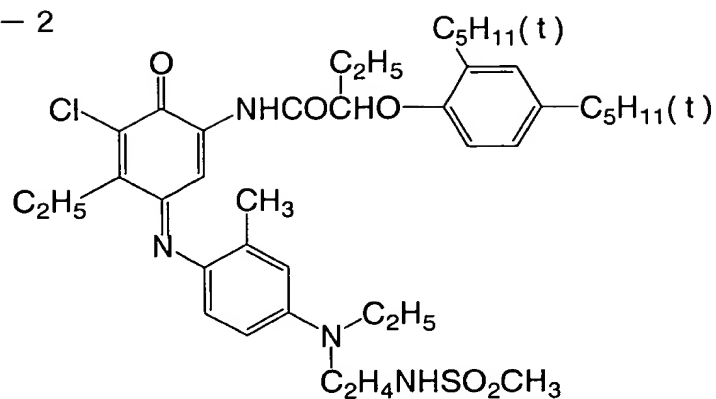
MM-3



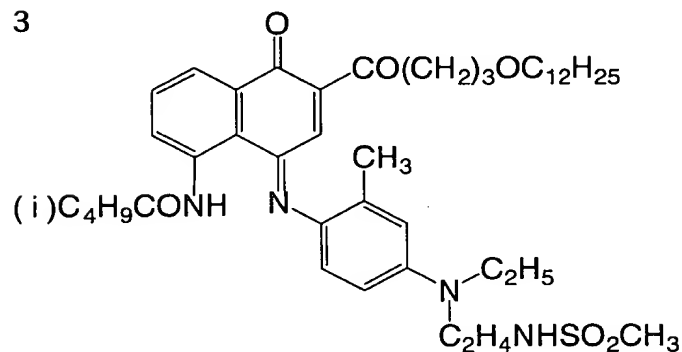
[0255]

[Formula 38]

CC - 2



CC - 3



[0256]

[Table 6]

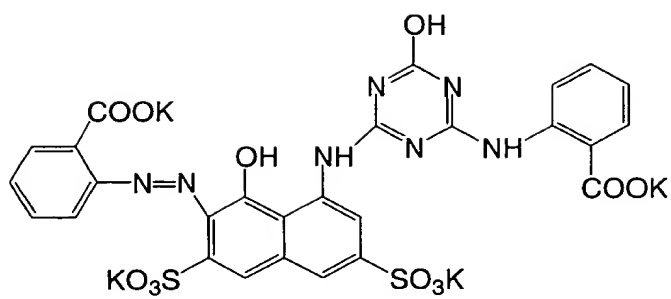
Table 5: Comparative ink set 215

	Light magenta	Magenta	Light cyan	Cyan	Yellow	Black
Dye (g/l)	A-1 7.0	A-1 28.0	A-2 8.75	A-2 35.0	A-3 14.7 A-4 14.0	A-5 20.0 A-6 20.0 A-7 20.0 A-3 21.0
Diethylene glycol (g/l)	150	110	130	200	160	20
Urea (g/l)	37	46	-	-	-	-
Glycerin (g/l)	130	130	150	180	150	120
Triethylene glycol monobutyl ether (g/l)	130	140	130	140	130	-
Diethylene glycol monobutyl ether (g/l)	-	-	-	-	-	230
2-Pyrrolidone (g/l)	-	-	-	-	-	80
SURFYNOL 465 (g/l)	10.5	11.5	11.1	9.8	-	-
SURFYNOL TG (g/l)	-	-	-	-	9.0	8.5
Triethanolamine (g/l)	6.9	7.4	6.8	6.7	0.8	17.9
Benzotriazole (g/l)	0.08	0.07	0.08	0.08	0.06	0.06
PROXEL XL2 (g/l)	3.5	2.5	1.8	2.0	2.5	1.8
Adjusted to 1 L with deionized water						

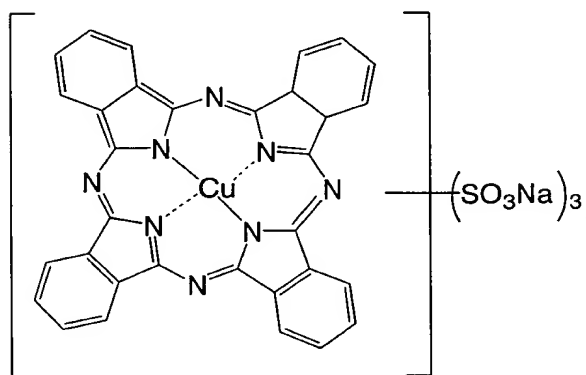
[0257]

[Formula 39]

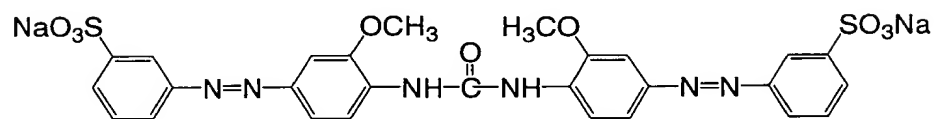
A - 1



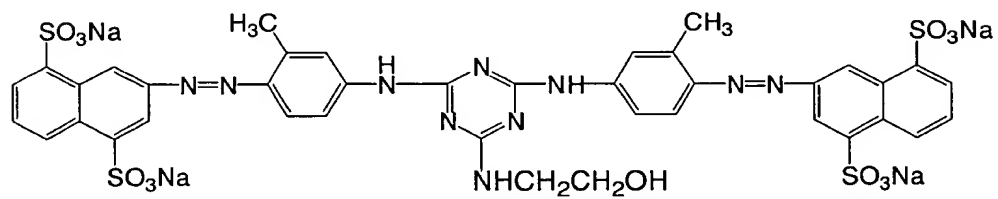
A - 2



A - 3



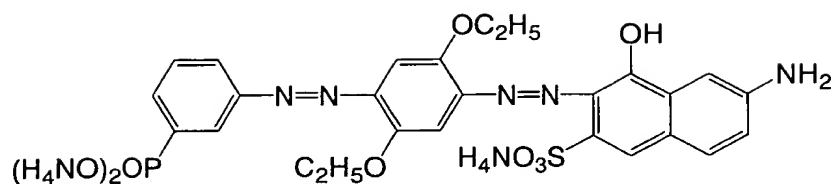
A - 4



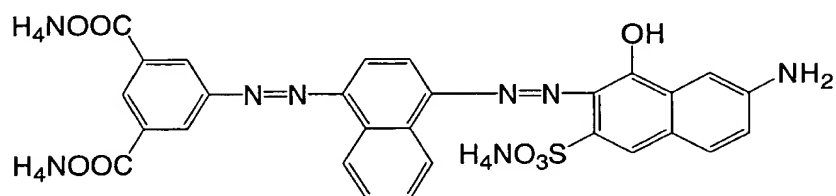
[0258]

[Formula 40]

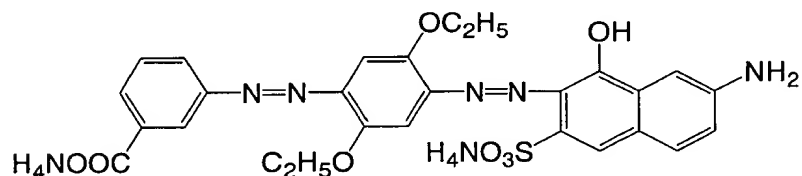
A - 5



A - 6



A - 7



[0259]

<Recording and Evaluation of Images>

Each of the prepared ink sets 201 to 215 was charged into a cartridge in an ink jet printer PM670C (trade name, manufactured by Epson Co., Ltd.), printed on ink jet paper photo glossy paper EX (trade name, manufactured by Fuji Photo Film Co., Ltd.), and evaluated as follows.

[0260]

- Printing Performance ① -

The cartridge was set in the printer and, after it had been confirmed that ink was discharged from all nozzles, 20 sheets of A4 paper were subjected to printing. Irregularity of the resulting printed characters was evaluated under the following criteria.

A: The printed characters were not irregular throughout printing.

B: The printed characters were irregular occasionally.

C: The printed characters were irregular throughout printing.

[0261]

- Printing Performance ② -

After the cartridge had been left at 60 °C for 2 days, the irregularity of printed characters was evaluated in the same manner as in printing performance ①.

[0262]

- Drying Characteristics -

A stain on a finger upon contacting with printed letters just after printing was evaluated visually, and ○ was assigned to good drying characteristics, while □ was assigned to poor drying characteristics.

- Bleeding of Thin Line -

Each of the yellow, magenta, cyan and black inks was used in

printing to form a thin line, and bleeding of the thin line was evaluated visually (evaluation ①). For evaluation of the black ink, a thin line of the black ink was printed after solid printing of the magenta ink, and bleeding of the thin line upon contact of the two colors was evaluated visually (evaluation ②).

[0263]

- Water Resistance -

For water resistance, the resulting images were dipped in deionized water for 10 seconds, and bleeding of the images was evaluated visually.

- Image Fastness Properties -

For image fastness properties, each of the yellow, magenta, cyan and black inks was used in printing to form a sample of printed characters and measured for thermal shelf stability in the dark, that is, residual degree of color (%) as shown below.

Under conditions of 80 °C and 10 % RH, the density ratio before and after storage of the sample for 14 days was determined as the residual degree of color (%) in the following manner.

- Residual degree of color (%) = (density after being left for 14 days at 80 °C and 10 % RH)/density just after printing × 100

Each ink was evaluated to one of the following 4 ranks: “A” was given when the residual degree of color was 80 to 100 %; “B” when the residual degree was 60 to 80 %; “C” when the residual degree was 40 to



60 %; and “D” when the residual degree was 40 % or less.

The results are shown in Tables 6 and 7.

[0264]

[Table 7]

Table 6: Evaluation results of ink sets 201 to 215

Ink Set	Printing performance ①	Printing performance ②	Drying characteristics	Bleeding of thin line ①	Bleeding of thin line ②	Water resistance	Remarks
201	A	A	○	○	○	○	Comparative Example
202	A	A	○	○	○	○	Present Invention
203	A	A	○	○	○	○	Present Invention
204	A	A	○	○	○	○	Present Invention
205	A	A	○	○	○	○	Present Invention
206	A	A	○	○	○	○	Present Invention
207	A	B	○	○	○	○	Comparative Example
208	A	A	○	○	○	○	Present Invention
209	A	A	○	○	○	○	Present Invention
210	A	A	○	○	○	○	Present Invention
211	A	B	○	○	○	○	Comparative Example
212	A	A	○	○	○	○	Present Invention
213	A	A	○	○	○	○	Present Invention
214	A	A	○	○	○	○	Present Invention
215	A	A	×	×	×	×	Comparative Example

[0265]

[Table 8]

Table 7: Residual degree of color in ink sets 201 to 215

Ink Set	Residual degree of color (%)				Remarks
	Yellow	Magenta	Cyan	Black	
201	C	C	C	C	Comparative Example
202	B	B	B	B	Present Invention
203	B	B	B	B	Present Invention
204	A	A	A	A	Present Invention
205	A	A	A	A	Present Invention
206	A	A	A	A	Present Invention
207	C	D	D	D	Comparative Example
208	B	C	C	C	Present Invention
209	B	C	C	C	Present Invention
210	B	C	C	C	Present Invention
211	C	D	D	D	Comparative Example
212	B	C	C	C	Present Invention
213	B	C	C	C	Present Invention
214	B	C	C	C	Present Invention
215	B	C	C	B	Comparative Example

[0266]

(Example 3)

The same ink prepared in Example 2 was charged into a cartridge in an ink jet printer BJ-F850 (trade name, manufactured by Canon Co., Ltd.), printed on ink jet paper photo glossy paper EX (trade name, manufactured by Fuji Photo Film Co., Ltd.) and evaluated in the same manner as in Example 2, to give the same results as in Example 2.

[0267]

From the results in Examples 1 to 3, it is clear that the inks for

ink jet recording according to the present invention have a significant improvement in stability with time. Further, the ink sets using the inks for ink jet recording according to the present invention were excellent in printing performance, drying characteristics and water resistance, and excellent in performance in printing a thin line without bleeding. Further, the effect of improving image fastness properties was significant.

[0268]

[Effects of the Invention]

According to the present invention, there can be provided: an ink for ink jet preferable for a thermal, piezoelectric, electric field or acoustic ink jet recording system, not depending on paper, excellent in color reproduction and color tone when printing on an arbitrarily selected paper, capable of high recording density, excellent in ink penetration into a photograph-quality paper, free of staining just after printing, excellent in image water resistance and image fastness properties, and also excellent in the stability of the ink with time and in discharge stability; a method of manufacturing the ink for ink jet; and an ink jet recording method capable of high-quality recording by use of the ink for ink jet.

[DOCUMENT NAME]      ABSTRACT OF THE DISCLOSURE

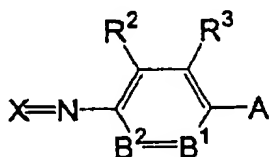
[SUMMARY]

[OBJECT]      To provide an ink for ink jet preferable for a thermal, piezoelectric, electric field or acoustic ink jet recording system, not depending on paper, excellent in color reproduction and color tone when printing on an arbitrarily selected paper, capable of high recording density, excellent in ink penetration into a photograph-quality paper, free of staining just after printing, excellent in image water resistance and image fastness properties, and also excellent in the stability of the ink with time and in discharge stability.

[MEANS FOR SOLUTION]      An ink for ink jet which includes a water-insoluble ionic group-containing polymer added to a colored fine particle dispersion containing at least a hydrophobic high-boiling organic solvent having a boiling point of 150 °C or more and an oil-soluble dye. In a preferred embodiment, the water-insoluble ionic group-containing polymer is converted by emulsification dispersion into a fine particle dispersion and added to the colored fine particle dispersion, and the oil-soluble dye is represented by the following general formula (I).

[Formula 1]

General formula (I)



[SELECTED FIGURE]

None